MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXXVIII NOVEMBER–DECEMBER, 1946 NO. 6

SOME BASES FOR MYCOLOGICAL PROGRESS *

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Progress is a problem which has engaged the attention of many thoughtful men. Nor should we put this only in the past tense for the problem of social progress is now uppermost in the minds of many thinking persons. Lucretius, a Roman of the first century, B. C., is credited with first using the word "progress" in the modern sense of "going ahead" as against "going backward." This has been an ever changing world; in some cases the changes are merely evolution; and evolution, however, is not synonymous with progress.

A friend of mine, who is a teacher of English Literature, recently said that in his search for a common belief among college students, he has found only one first-rate candidate—the belief in progress. He has put it in these words, "Almost all of them have seen a cave-man—in textbooks or movies or comic strips. They can see the difference between themselves and Tarzan at once, the latter ill-clad, uttering wild cries, lacking electricity. Some students also see progress in the strides of science—new inventions, greater speeds, the atom bomb—without inquiring closely about the effects of these newer and faster gadgets. Some see progress in 'the survival of the fittest' and biological slogans. Some see it in books of ancient history. Girls see it in a succession of old

* Address of the President, 1945, Mycological Society of America, and of the Vice President of the A. A. A. S. and chairman of the Section on Botanical Sciences, 1945, St. Louis, Missouri, March 28, 1946. Contribution from the Department of Botany, The Pennsylvania State College, No. 154.

[MYCOLOGIA for September–October (38: 477–607) was issued October 4, 1946]

styles of dress, most of which are unfamiliar and therefore inferior." He points out that the doctrine of progress has been held by many in an unthinking manner especially in recent centuries. "One can hardly read any writer of prominence," he says, "without finding somewhere a casual mention of human progress as a part of the furniture of his mind."

The philosophical viewpoint is that progress not only consists in performing a function with greater ease or with greater proficiency or more efficiency but also in doing something desirable. The test of desirability is more difficult than that of efficiency. We have certainly developed more effective weapons for war. Being able to kill and to be killed by thousands may prove our efficiency but it is a fair question whether it constitutes progress. "That which is desirable, all things considered, is the final test of progress." Benjamin Franklin in predicting the power of men over matter showed his appreciation of the potentialities of natural science but he was also aware of its dangers as indicated by his plea, "O that moral science were in a fair way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn to know what now is improperly called humanity."

In choosing to discuss "some bases for mycological progress" it was in my mind to present some ideas that might make for progress in the future. But mycology has made much progress since the days of the herbalists of the 17th century. It may assist us in our thinking to review some of the bases for past progress.

An early basis of progress was the microscope. By the time of the publication of Micheli's *Nova plantarum genera* in 1729, the microscope had become a working-aid and the author made use of it. His work was an example of good scientific method for the time. He germinated spores of the larger fungi and observed both the mycelium and the sporophores. Germination of spores of the microfungi was not recorded until much later (1807). Early interpretations of microscopic studies of fungi were based upon the understanding of the parts of flowering plants. "The sporeheads, or large spores, seemed like the fruiting pods of Lilliputian plants, each containing its quota of seeds." DeCandolle thought that the spores of *Uromyces* and *Uredo* contained small grains, or spores. A telio-

spore he thought might contain 100 such "spores." But the advances made with the microscope did not continue uninterruptedly. Fries, during the middle of the 19th century, made great contributions to the knowledge of the larger fungi and developed great prestige. Apparently he did not use the microscope and perhaps that accounts for his poor opinion and antiquated conception of the parasitic fungi.

Another basis of progress was the substitution of the careful study of the orderly development of a few species for the previous method of comparing the gross appearance of many forms. Cultural demonstrations brought about what may be called the life-history concept. They resulted in the recognition of a mycelium as a vegetative body, of the possibility of the production of more than one kind of spore in a life cycle, and ushered in the change from the old to the modern viewpoint. For a real contribution to this kind of progress we are indebted to deBary. These advances were made from 1853–1863.

During the first three quarters of the 19th century new species were being recognized and named from all parts of the world. The descriptions appeared in a variety of journals, reports, and books. Many of these were not widely circulated. It is little wonder that workers soon found it difficult to know whether or not a specimen under consideration was already named. It may well be added that this condition still prevails. I shall return to it later. Thus it happened that many species were named more than once. It has been asserted that many mycologists of those days were deterred "from describing supposedly new species for fear of duplication." That statement may meet with some "eyebrow lifting" but I remind you that I am only quoting. An important step toward overcoming this situation was the publication of the *Sylloge Fungorum* inaugurated by Saccardo in 1882. The immediate effect was the stimulation of systematic mycologic activity. This monumental work continued into twenty-five volumes, the last appearing in 1931. During this period mycological journals made their appearance in various countries and taxonomic work proceeded at a rapid pace.

The next impetus in the study of fungi came from researches on the nucleus and its behavior. These gave a new direction to

mycological advances. As life histories revealed by cultural studies had been recognized as important, so nuclear developments revealed by cytological studies came to be recognized as important. The applications of cytological methods to the study of fungi began with the work of Dangeard in 1894 and soon were under way on a large scale by a host of investigators. In the last few years many genetical studies have been made and highly significant results obtained.

Many diseases of plants are caused by fungous parasites. The great advances in the field of plant pathology have had significant influence upon the development of mycological science. Many species of fungi have been isolated, cultured, and identified, by the pathologists. It is necessary to be able to name the pathogens and taxonomy becomes important.

This is a brief and unsystematic survey of past progress. No attempt has been made to make it systematic. Woodrow Wilson once said that any systematic writing is immoral writing, because no man knows enough about anything to write about it systematically. "No man," he said, "knows more of a certain subject than some parts." In the beginning, I intended to be cautious by proposing to talk about some, not all, bases of mycological progress. In discussing the effects of the microscope, the life-history concept, Saccardo's Sylloge, and cytological and pathological investigations, the intent has been to provide a certain amount of background or perspective. It has been said that perspective is the chief aim of all education, that facts are only scaffolding whereas perspective is the structure itself.

The earliest mycologists were interested in taxonomy. From those early times to the present there have always been some workers who have been interested in describing, naming, and classifying. It is well that morphology, physiology, cytology, and genetics have their devotees—it is also well that there are those who are willing to devote themselves to taxonomy. They say nowadays that a nation cannot advance without a sound economy. We might paraphrase this and say that mycology cannot advance without a sound taxonomy.

It seems worthwhile to present some of the problems which taxonomic workers encounter. This means both the problems

which are inherent in taxonomic studies and also the wider limitations which often operate to check progress and to break the continuity of advances for which a groundwork may have been well established. Taxonomic work in general, as well as in mycology in particular, has a checkered history. Its advances have been piecemeal. Even at the risk of repeating certain things which I have already presented in another paper,[1] I propose to discuss some of the reasons why mycologic taxonomy does make more substantial progress and to present some of the bases for better and more continuous progress in the future. There is danger in this—one may be accused of being too idealistic. But I like to think that Walter Lippman was right when he said, "Ideals are not hallucinations. They are not a collection of pretty and casual preferences. Ideals are an imaginative understanding of that which is desirable in that which is possible." I am also heartened by Bacon's observation that "The light which we have gained, was given us, not to be ever staring on, but by it to discover onward things more remote from our knowledge." Things haven't changed much since Bacon's time for he pointed out that where there is a desire to learn, "there of necessity will be much arguing, much writing, many opinions. . . ." This statement will doubtless be accepted by all, but his further statement that "opinion in good men is but knowledge in the making" will probably be challenged by many.

In the next several paragraphs I am going to quote freely from my previous paper, already mentioned, because I think the sentiments expressed bear repetition and also because I cannot state them any more clearly or forcefully. I might add that I have written abstractly while thinking concretely.

It seems likely that we must depend largely upon institutions to furnish the support for taxonomic mycology. Of course we have not been without interested laymen who have done their work chiefly or wholly without institutional support. To them great credit is due. We should have more of them. The fact remains that we must look to the universities, experiment stations, research institutions, or governmental departments for most of the needed resources. Even where these agencies are involved it is still true

[1] The importance of taxonomic studies of the fungi, Torreya **43**: 65–77, 1943.

that the ambition, industry, and perseverance of individual staff members are more responsible for the advances made than are the plans and direction of the administration. We have been hearing a good deal about institutional research but so far as taxonomic work with fungi is concerned we believe an analysis would show that research in this field is chiefly due to individual initiation rather than to institutional planning. It may happen that an institution will make an effort to continue a certain type of research after it has been inaugurated and successfully carried on by one of its staff members and will then refer to the program as an institutional program. More often it happens that a real leader appears and develops successfully a line of work which is supported (more or less) during his years of activity but which is dropped by the institution afterwards. Such instances indicate the correctness of the conclusion that there is often no such thing as an institutional program. There are, of course, exceptions but we feel safe in saying that the exceptions prove the rule rather than make it. We have inserted the parenthetical phrase—more or less—because we are sure that institutional support even when forthcoming during the height of the program is often more apparent than real. Certainly it is true that many of our productive mycologists have had to earn their "bread and butter" with teaching and routine duties and have had left only a small percentage of their time and efforts for the kind of work which they were so well qualified to pursue.

Someone may well ask why these difficulties are raised in connection with taxonomic research when they exist in so many lines of research activity. There are several reasons for this. Of course I need not explain why I single out mycological taxonomy.

The source materials for taxonomic research are in large part not commercial commodities. They consist of specimens, rare books, separates, indexes, and illustrations, which are accumulated only with time, patience, correspondence, and exploration. When such collections have finally been put together in an institution they should be used by more than one generation of workers in that institution. Or, if that is not possible some method should be worked out by which they become available to succeeding investigators in other institutions.

There are now in existence some collections of microfungi where spore measurements and drawings accompany literally hundreds of specimens. Such aids are indispensable for taxonomic studies and when available not only save the time necessary to duplicate them elsewhere but help to prevent errors and misconceptions. There are also herbaria of fleshy fungi where great accumulations of photographs, drawings, and notes make them of the utmost importance to other workers. This is not a plea for the centralization of mycological taxonomy. It is rather to call attention to the fact that enormous resources are frequently accumulated and then neither used nor made available for use. Since our modern concepts fix the application of names by types rather than by descriptions, it is a fair question whether type specimens should ever be personal or institutional property. The difficulties may seem insurmountable but this is not a foregone conclusion. Surely we shall make no progress until the workers themselves reach a keener appreciation of the situation.

There are other factors which bear on the progress of taxonomic work with the fungi. Even though a staff member may have the ability and enthusiasm to carry on work of this sort, it may be, as previously indicated, difficult for him to obtain the full cooperation of his institution. Projects which have more evident economic aspects frequently elicit more favor with administrative officials in publicly supported institutions. This is true in spite of the basic relation of taxonomic studies of the fungi to many phases of plant science, medicine, and industry. It is easy to comprehend why this attitude prevailed in the early days, but it is not so easy to see why the value of fundamental work of this sort has not eventually come to be recognized more generally.

And again, even though there may be institutional approval so far as the time of the worker is concerned, it is often difficult to secure funds for the type of maintenance which is essential for taxonomic projects. For a project requiring special apparatus, machinery, glassware, and chemicals, it is usually not difficult to secure funds. But to secure funds for the purchase of specimens, photographs, particular books, separates, periodicals, indexes, and exploration, may be difficult or well-nigh impossible. It is generally conceded that a research worker is not expected to get along

with the equipment and supplies which are in general stock but is entitled to special expenditures for his project. Not so with library facilities. He may be expected to get along with what the institutional library provides. He may of course compete for more than his share of the general library funds but this is not always satisfactory even if partially successful. The use of research funds for special library facilities is much less common than for special material equipment. The problem of publication is a closely related one. Monographic treatises are often expensive to publish and the demand for them may be slight and slow. The fact that publication is difficult tends to discourage this type of work.

Where, then, is progress? Workers come and go. Change is incessant but are we sure that we are pursuing an upward path? As we have pointed out, the isolation of workers and the attitude of institutions has caused repetitions upon a grand scale as well as upon a small one. In order to get going, an individual must spend much time doing things that have been done before and accumulating material that already has been accumulated elsewhere. Perhaps that is the way of the world and it must be so. Marcus Aurelius said that although there is continual change everywhere, it runs in cycles and does not escape their confines. The social scientists put it another way. They recognize the repetitions through the whole of history and refer to the same dramas, with the selfsame scenes reproduced, with merely a change of actors.

Coming now to the problems of mycological taxonomy, is there anything that we can do to avoid the necessity of so much unproductive repetition? What can we do about valuable things that are no longer being used and yet not available? Individuals and institutions must be physically separated, but can they not be brought scientifically closer together?

I propose that we should have a national mycological institution. I have not gone so far as to draw up a charter or a constitution. Neither have I tried to solve the problem of support. It seems safe to assume in these days of the wide interest in research on a national scale that both public and private funds could be had if the Mycological Society of America would determine what sort of an organization is desirable.

I am not proposing a new research institution. What I have in

mind is an institution in the nature of a bank, or clearing house, which would have on deposit a wealth of scientific resources—specimens, indexes, separates, and other aids—and perhaps even money. Neither am I proposing cooperative research but rather cooperation in research, a very different matter.

First of all there would be constituted a national mycological herbarium. Operation as such, and not as a part of any of the government departments, should enable it to play a role not now played by any other herbarium. I have already said that it seems a fair question whether a type specimen should ever be regarded as private property.[2] But as long as there is no real public "treasury" in which to deposit them, they are likely to remain in their place of origin. Of course they can now be sent to any of the large herbaria but incentive to do so is not very great and certainly pressure to do so is lacking. Fortunately material of many mycological specimens is divisible so that portions of types could be furnished by an author if he felt the urge. It should not be left to chance. The kind of national organization I have in mind would immediately contact authors of new species. I believe the response would be excellent. And the campaign for type specimens should not be limited to solicitations within our own country, but should be world-wide. If actual specimens were not obtainable there are possibilities of photographs, drawings, and special notes. It has been well said that considering types are one of the basic assets of botanical science, the complacency of American botanists toward them is indeed remarkable.

It seems safe to conclude that a national institution could become without doubt a repository for many privately organized collections which are no longer in the hands of the originator and are not being used by a successor. Acquiring such collections by loan, provided they could not be obtained by title, would help much.

[2] After writing this, my attention has been drawn to a similar statement by F. R. FOSBERG in *Science* **89**: 245 (1939), "Types and other historic specimens can no longer be regarded as the private property of individuals or institutions, but must be treated as a legacy, entrusted to us by the botanists of the past for the benefit of botanical science, present and future." The same author has presented well the case for the necessity of segregating and safeguarding type specimens at all times and especially during the dangers of war. See *The Journal of Botany*, November, 1938, pp. 327–330, and *Science* **96**: 515–516 (1942).

The staff in this national institution should be able to keep up indexes of literature on a scale beyond that possible for individuals or for most institutions. Without a current Saccardo many workers need help with taxonomic literature. Interlibrary loans, once simple and direct, are now difficult and restricted. This general reference to mycological literature leads naturally to the subject of publication. Monographs are frequently long and with illustrations; the expense of publication may be great in comparison with any possible income from sale. I know of two such manuscripts which should be published but which cannot find a commercial or institutional publisher. This mycological bank we are talking about should have money in it for such good work.

It should have money also to aid in sending representatives to International Congresses, especially if rules of nomenclature are to be considered. Most of you know that we must have international rules of nomenclature. The only way so far devised to secure such rules is through International Congresses. As far as I am able to learn most of the delegates "delegate" themselves. By that I mean that societies and organizations appoint as delegates those who have decided to attend on their own. The representatives are, therefore, not necessarily those best qualified to take part in such important proceedings, but rather those who are able or at least willing to finance the trip themselves. I wonder what would be the outcome if our national government selected delegates on such a basis to other international meetings where matters affecting the welfare of the nation are under consideration.

After considering the problems of progress in general and the bases of progress in mycology in particular, both historically and with regard to future developments, I am reminded of the story of the two little girls who were comparing progress in catechism study. "I've got to original sin," said one. "How far have you got?" Said the other: "Oh, I'm way beyond redemption." That seems to be the place where this discussion should end today but I hope it will be continued by the Society and that further progress along the lines suggested will not be too long delayed.

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STUDIES IN THE GASTEROMYCETES XIV. THE GENUS CHLAMYDOPUS

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(with 7 figures)

The tribe Phellorineae consists of three closely related, cosmopolitan, monotypic genera, *Phellorina* Berkeley, *Dictyocephalos* Underwood and *Chlamydopus* Spegazzini. These three genera have sporocarps elevated at maturity on a definite, elongated stipe, basidia in fasciculate clusters persistent at maturity, pulverulent gleba and colored, continuous, verrucose spores. The endoperidium in each genus consists of two distinct structures, a permanent outer basal region formed by the expanded modified stem-apex and an inner layer lining the entire glebal cavity. In *Dictyocephalos* the dilated stem-apex portion of the endoperidium becomes hard and leathery with age (Long & Plunkett, 1940). It may be a mere rim or collar around the base of the sporocarp, or extend upward 2–3 cm. as a very irregular, jagged, saucer-like wall whereas the inner lining continues beyond the leathery basal part as a thin membrane, covering the entire gleba, and is shed on dehiscence. The leathery, basal part remains permanently attached. In *Phellorina* the expanded stem-apex forms an urceolate leathery permanent endoperidium for two thirds to five sixths of the length of the sporocarp leaving a small top part of the gleba covered only by the membranous inner layer, which falls away during dehiscence. In *Chlamydopus* the endoperidium completely covers the gleba and on maturity develops an apical stoma.

KEY TO THE THREE GENERA

1. Exoperidium continuous with stipe, endoperidium an urceolate expansion of the stem-apex.....*Phellorina*
2. Exoperidium not continuous with stem, sporocarp seated on the expanded stem-apex, stem volvate.....3
3. Gleba cellular, dehiscing by the irregular breaking away of the peridium *Dictyocephalos*
3. Gleba not cellular, dehiscence by an apical stoma.....*Chlamydopus*

CHLAMYDOPUS Spegazzini
An. Mus. Nac. Buenos Aires **6**: 189. 1899

Sporophore hypogeous, enclosed in a volva or universal veil during early stages of growth, erumpent at maturity. *Peridium* double; the *universal veil* breaking away in pieces. *Endoperidium* coriaceous to membranous, tough, dehiscing by an apical stoma. *Stipe* dilated at apex, not socketed, long, stout, becoming woody. *Gleba* powdery, having capillitium, spores and fasciculate basidia. *Columella* none. *Spores* globose, colored, continuous, usually verrucose. *Basidia* bearing 1 to 4 spores apically on short sterigmata.

TYPE SPECIES: *Tylostoma meyenianum* Klotzsch.

DISTRIBUTION: North America; South America; North Africa; Australia.

CHLAMYDOPUS MEYENIANUS (Klotzsch) Lloyd, Myc. Writ. **1**: 134–135. 1903.

Tulostoma meyenianum Klotzsch, Nov. Act. Caes. Leop. Carol. Nat. Cur. **19**: 243. 1843.

Tulostoma deserticola Philippi, R. Florula Atacamensis p. 130 (p. 50 of reprint). 1860.

Tylostoma maximum Cooke & Massee, Grevillea **15**: 94. 1887.

Chlamydopus clavatus Speg., An. Mus. Nac. Buenos Aires **6**: 189. 1899.

Chlamydopus amblaiensis Speg., *ibid.* 1899.

Tylostoma clavatum Sacc. & Sydow, Syll. Fung. **16**: 234. 1902.

Tylostoma amblaiense Sacc. & Sydow, *ibid.* 1902.

Sporophore originating 3–8 cm. below the surface of soil. *Sporocarp* subglobose to depressed-globose to rarely slightly concave at base, 5–18 mm. tall by 10–30 mm. wide, firmly attached to the dilated stem-apex. *Exoperidium* none (excluding the universal veil). *Endoperidium* membranous-subcartilaginous, tough, persistent, pinkish buff to pinkish cinnamon, smooth. *Collar* none, or on some plants a pseudo-collar formed by the rupturing of the cortical layer of the stem at base of peridium. *Mouth* apical, plane, indefinite, 0–6 mm. in diameter, often enlarged and irregularly lacerate in age. *Stipe* 4–15 cm. long by 2–15 mm. thick at top by 1–10 mm. thick at base, woody to corky, solid or rarely with a small central cavity, context more or less porous, curved, terete or angular, often flattened, especially the upper half, longitudinally sulcate or rarely smooth, attenuate below, scales fibrillose-silky to flat-appressed, or none, cartridge buff to cinnamon, a few pecan

FIGS. 1–2, *Chlamydopus meyenianus* × 1. Fig. 1, volva-cup and false exoperidium; fig. 2, type of *"Tylostoma gracile"* White.

brown with extreme age. *Volva* a universal veil, bizonate, dehiscence circumscissile along the equator, upper portion of volva or volva-cap thin, membranous, very fragile and brittle, verrucose (FIGS. 1 & 3), warts coarse, usually 2 × 2 mm. thick, quadrangular, normally deciduous in pieces as the stipe elongates, but sometimes this verrucose cap remaining on the endoperidium as a false exo-

peridium (FIGS. 1 & 3), inner surface of volva-cap buff pink, outer surface pecan brown to walnut brown, warts dingy white; the lower half or volva-cup smooth externally, two-layered, of coarsely chambered tissue, obovate to cupulate to subcylindrical, persistent, 9–12 mm. tall by 10–20 mm. wide at top, walls 1–2 mm. thick, outer layer thin, membranous, inner layer thick, often rotting away leaving the outer coat a thin tough membrane covered with dirt. *Annulus,* rarely a pseudo-annulus occurs (FIG. 4) formed of the remains of the volva-cap which on elongation of the stem were left on the upper part of the stem simulating a true annulus, breaking into pieces and soon deciduous, leaving a normal stipe with no signs of any annulus ever having been present. (A somewhat similar universal veil or volva is found in *Battarrea laciniata* [Long **1943**], where the outer volva is triplex having three different zones of tissue.) *Radicating base* none. *Gleba* ferruginous to Hay's russet. *Capillitium* hyaline to slightly tinted, not abundant (in specimens at hand), threads not as well defined as in *Tylostoma,* flaccid, 3–5 μ thick, septa not seen. *Spores* globose, uni-guttulate, 5.6 to 7.5 μ usual size 7 μ. *Epispore* fulvous, moderately but not densely echinulate, rarely smooth.

TYPE LOCALITY: South America near Arequipa, Peru.

ILLUSTRATIONS: Klotzsch, Nov. Act. Caes. Leop. Carol. Nat. Cur., fungi of Meyen Collections, tab. 5, fig. 4. Lloyd Myc. Writ. **1**: The Genera of Gasteromycetes, pl. 2, fig. 20, p. 14; Lloyd Myc. Writ. **1**: pl. 10, figs. 1–3; Lloyd Myc. Writ. **1**: The Lycoperdaceae of Australia, New Zealand and Neighboring Islands, fig. 6, p. 9. Cunningham, the Gasteromycetes of Australia and New Zealand, pl. 29. fig. 1, and pl. 36, fig. 53. White, The Tylostomataceae of North America, pl. 35, figs. 1–6. Spegazzini, An. Mus. Nac. Buenos Aires **6**: pl. 4, fig. 2, and fig. 3 as *Chlamydopus amblaiensis* l. c.

HABITAT: usually solitary, in sandy, sand-clay, or volcanic soil, on sand dunes, and in gypsum flats; in the open or usually in partial shade of desert vegetation; in arid or semiarid regions.

DISTRIBUTION: NORTH AMERICA. **Arizona:** Pima County, near Tucson, elevation 2400 ft., *C. L. Shear,* April 13, 1901, in Herb. Bureau of Plant Industry (1 plant). **California:** San Bernardino County, near San Bernardino, elevation 1080 ft., *O. A. Plunkett,* comm. *Warren Travell,* March 1929, in University of California Herbarium at Berkeley, *506660* (1 plant). Western Mohave Desert, *I. M. Johnson,* in Lloyd Myc. Coll. *5623* (1 plant). Rverside County 6–8 miles beyond Indio, elevation 20 ft. below sea level. *H. E. Robert,* spring of 1940. Herb. Bureau of Plant Industry, in Morse

FIGS. 3–5, *Chlamydopus meyenianus* × 1. Fig. 3, volva-cup and pseudo-exoperidium; fig. 4, plant with false annulus; fig. 5, plant from type locality in Peru.

Coll. *650* (1 plant). Mohave Desert, Los Angeles County, Lancaster, elevation 2350 ft., *Mildred Stein*, May 1940, in Morse Coll. *650* (1 plant). **New Mexico**: Dona Ana County, Mesilla Park, elevation 3865 ft., *W. A. Archer*, April 10, 1915, in Lloyd Myc. Coll. *5628* (2 plants). *E. O. Wooton*, April 1910, in Lloyd Myc. Coll. *5640* (2 plants); *T. D. A. Cockerell*, May 1898, in New York Botanical Garden (several plants); on mesa north of

A. & M. College, *F. Garcia,* comm. *E. O. Wooton,* April 1894, no. *101* Herbarium of A. & M. College (1 plant), now in the New York Botanical Garden under the name *Tylostoma gracile; F. Garcia,* comm. *J. B. Ellis* (1 plant), in New York Botanical Garden under the name *Tylostoma campestre;* on mesa, 1 mile N.E. of A. & M. College, *Clay Smith,* comm. *H. L. Barnett,* April 1941, *9956* Long Herb. (1 plant). Jornado Experimental Range about 28 miles east of Las Cruces on Highway 70, elevation 4150 ft., in open areas between the mesquite-sand dunes, *Ivan H. Crowell,* February 6, 1937, *8156* (1 plant); *W. H. Long* and *David J. Stouffer,* Sept. 8, 1941, *9607* (1 plant). Chavez County, in oak shinnery (*Quercus Harvardii*), 34 miles east of Roswell on Highway 380, elevation 3400 ft., *W. H. Long and David J. Stouffer,* April 19, 1942, *10083* (2 plants). Lincoln County, 8 miles south of Oscuro, elevation 5500 ft., *David J. Stouffer* February 20, 1942, *10021* (5 plants), October 27, 1942, *10271* (1 plant); *W. H. Long and David J. Stouffer,* April 18, 1942, *10101* (27 plants). Otero County, White Sands National Monument, elevation 4250 ft., in gypsum flats, west of first gypsum dune, one-quarter to one-half mile N.W. of Administration Buildings, *E. Ray Schaeffner,* August 15, 1941, *9686* (1 plant), August 30, 1941, *9958* (4 plants); *W. H. Long and David J. Stouffer,* September 13, 1941, *9646* (56 plants); *W. H. Long,* April 22, 1942, *10114* (87 plants). Luna County, 10 miles west of Deming on Highway 70, elevation 4300 ft., in mesquite-sand dunes, *W. H. Long and David J. Stouffer,* September 9, 1941, *9614* (1 plant), *11054* (7 plants); *W. H. Long,* April 24, 1942, *10061* (10 plants). Valencia County, 4 miles south of Belen bridge on Highway 6, elevation 4785 ft. in sand-clay soil on *Artemisia* areas, September 18, 1941, *W. H. Long, 7679* (2 plants); *W. H. Long and David J. Stouffer,* December 6, 1941, *9919* (3 plants). **Washington:** Franklin County, Pasco, elevation 381 ft., in deep sand dunes, *C. V. Piper,* May 20, 1899, in Lloyd Myc. Coll. *5625* (3 plants).

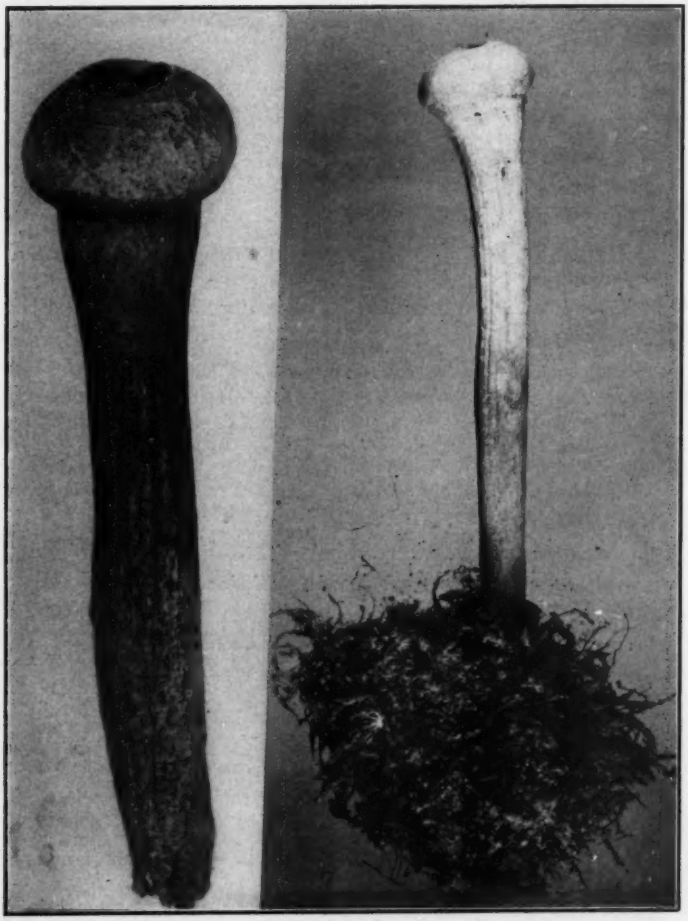
SOUTH AMERICA. **Peru:** Province of Arequipa, near Arequipa, elevation 8000 ft., in volcanic soil, at the base of the active volcano Misti, *P. J. F. Meyen,* in Berlin Museum as *Tulostoma meyenianum,* type locality. Yura, about 20 miles N.N.W. of Arequipa at base of extinct volcano, Chachani, elevation 8000 ft., *Karl P. Schmidt,* August 7, 1939, in Chicago Museum of Natural History, *1,014,666* (1 plant). **Chile:** Atacama Province, Desert of Atacama, between Cachinal de la Sierra and Agua de Profetas, elevation 9000 ft., *R. Philippi* No. *419* (several plants) as *Tulostoma deserticola.* **Argentina:** Province of Patagones, near Carmen de Patagones, in sand dunes near seashore, *Carlos Spegazzini,* September 1897, and February 1898, as *Chlamydopus clavatus,* type locality for genus; Salta Province near Amblaio, in very arid sandy hills, elevation 8200 ft., *Carlos Spegazzini,* January 1897, as *Chlamydopus amblaiensis;* Mendoza Province, in preandean hills of Potrerillos, near Mendoza, elevation 4500 ft., *Carlos Spegazzini,* March 1910, No. *1260,* abundant, as *Chlamydopus meyenianus.* Vicinity of Mendoza, Carnegie Institution of Washington, New York Botanical Garden, Explorations in South America, *J. N. Rose and P. G. Russell,* September 1915, *21473* (1 plant) as *Tylostoma* sp.

NORTH AFRICA: One specimen at Kew under name *Battarrea guicciardiniana* (according to Lloyd l.c.).

AUSTRALIA. **Western Australia:** Kalp, *J. B. Cleland* (his no. *357*), Lloyd Myc. Coll. *5631* (1 plant); Kalgoorlie, Gascoyne River, *M. Gribble*, June 1917, as *Tylostoma maximum;* Kurrawang, *Mrs. A. F. Cleland*, July 1918. **South Australia:** Millers Creek, *Dr. Campbell*, August 1921; Minnie Downs, *L. Resse*, July 1926; *Mr. Diets*, no locality given; **Victoria:** Miller, Mallee; Walpeup; Pink Lakes, Mallee near Underbool.

The altitudes and habitats for Australia are not available. All the collections listed from New Mexico are in the Long Herbarium at Albuquerque, N. M., unless otherwise stated. The above distribution shows that *Chlamydopus meyenianus* has a wide range in altitude and habitat. In South America this fungus extends from the shore of the Atlantic Ocean in Argentina, inland to elevations of 7000 to 8200 ft. then over the Andes to Peru at 8000 ft., thence up the west coast to Chile where it occurs at 9000 ft. in the Atacama Desert; thus it is rather widely distributed on both slopes of the Andes at high altitudes. In North America, *Chlamydopus* ranges from Southern California, eastward to New Mexico then North to southeastern Washington, with altitudes from 20 ft. below sea level to 5500 ft.

HABITAT: In South America this fungus is found on sand dunes, on rocky soil and in volcanic debris. In North America it has a wide variety of habitats, as follows: East of Roswell it grows on low sandhills in a remarkable forest of dwarf oaks which rarely grow taller than three feet; in the Oscuro area it grows on the tops and sides of mesquite-sand dunes in the partial shade of the mesquite trees. In the White Sands National Monument, the plants were found in gypsum flats in the partial shade of *Atriplex canescens, Lepideus alyssoides* and *Chrysothamnus latisquameus.* These gypsum flats are small valleys entirely surrounded by gypsum dunes (hydrous calcium sulfate) which have no drainage outlets, hence the soil is heavily impregnated with gypsum from rain water and from wind-blown particles of gypsum settling in the flats. The Jornado area consists of high mesquite-sand dunes with deep depressions between the dunes, the *Chlamydopus* grows in open spots in the depressions. The Deming area consists of low mesquite-sand dunes where the mesquite trees are small (4–8 ft.). This fungus grows on the sides and tops of the dunes, especially on dunes where the mesquite brush is dead or dying; the soil of this area has much clay in it. In the area southeast of Belen the fungus



FIGS. 6–7, *Chlamydopus meyenianus* × 1. Fig. 6, a very large obese form; fig. 7, plant from gypsum flats with large bulbous base of rootlets, hyphae and soil.

grows on low hills in a heavy sand-clay soil covered with *Artemisia bigelowii*.

Figure 7 shows the characteristic basal growth of *Chlamydopus* in the gypsum flats of the White Sands National Monument. The

majority of the plants have this large bulbous base, which is composed of rootlets of adjacent vegetation mixed with a mass of white hyphae, grains of sand and gypsum. At first we thought this was an example of root stimulation due to the *Chlamydopus* as described by Shantz and Piemeisel (**1917**) where they cite instances of stimulation of vegetable growth from "Fungus Fairy Rings," but a critical study of these bulbous formations led us to doubt that such an explanation was correct. These bulbs are unusual in that they are found around the volva-cups extending up on the base of the stems where the volva-cap had been; the rootlets and fungus hyphae are also in the sand which filled the volva-cups after stem elongation. The sporocarps and volva-caps are entirely free of rootlets, hyphae and sand particles, in other words the bulbs are limited to the volva-cups and adjacent portions of the stem. All of the volva-cups found on this gypsum area are filled with rootlets, hyphae and sand; also many stems have rootlets protruding from that portion buried in the soil, indicating that this peculiar bulbous formation originated *after* stem elongation.

Most of the rootlets under the microscope show a multitude of hyphae radiating in all directions from them, but many of the rootlets have masses of hyphae parallel to them. Apparently as soon as the stem elongates, the rootlets and hyphae become active filling the soil inside and outside of the volva-cup thereby producing the globose bulb. If this white fluffy mycelium originated from the *Chlamydopus* then why wait to grow until the universal veil is ruptured, if this white fungus is not a part of the *Chlamydopus* mycelium then again why wait till elongation to become active? These bulbous masses around the volva-cups (FIG. 7) occur only on *Chlamydopus* plants growing in the gypsum area, none were found on any plants growing in other areas (FIGS. 1 & 3). The gypsum evidently is the cause of this bulbous growth. It seems that the *Chlamydopus* plants in the presence of gypsum gives off substances which attract the rootlets of green vegetation as well as attracting the fungus hyphae. Special efforts were made to find the "egg" stages of *Chlamydopus* but none were found, hence we have only old and more or less weathered plants for study. Many of these questions would be answered if we could get the "egg" stages in the gypsum soil. According to Cunningham (l. c.), the

"egg" and stems of *Chlamydopus* have a gelatinous matter in them before elongation, if such is true for our plants then this gelatinous material, or what was left of it after elongation, might be the attraction for the rootlets and the white fungous mycelium, if so, then why do not plants of *Chlamydopus* everywhere have this bulbous base? But, as previously stated, these bulbs are limited to the gypsum areas.

Cunningham (l. c.) finds plants in Australia with stems 35 cm. long and states that these "large specimens may possess a compound peridium when the glebal chamber is divided into several smaller chambers. The top of the sporocarp then becomes somewhat pitted, the depressions corresponding with the positions occupied by the various peridial walls." We do not find any plants with stems longer than 15 cm. nor any with compound peridia as described by him. If this species were not so distinctive, some "splitters" might easily make a "new species" of the plants with these long stems and compound peridia. We have a similar possibility in *Dictyocephalos* (Long & Plunkett, l. c.) where the amazing variations in size, shape, scales and other characters are so many that numerous "new" species could be made from aberrant individuals by writers who believe such characters are valid criteria for differentiating species. The description of *Chlamydopus* given here was made from New Mexico material.

DISCUSSION OF SYNONYMS

Tulostoma meyenianum Klotzsch (**1843**) was the name for the original type material collected in Peru by Meyen on which is based *Chlamydopus meyenianus.*

Tulostoma deserticola Phil. (**1860**) is a name applied to our plant found in the desert regions of Atacama in Chile.

Tylostoma maximum Ck. & Mass. (**1887**) was found in Australia but is identical with our plant according to Lloyd (l. c.). The above species were named before the genus *Chlamydopus* was erected.

Chlamydopus clavatus Speg. (**1899**) is the name given to a South American collection from near the shore of the Atlantic Ocean; the author overlooked the older name *T. meyenianum.*

Chlamydopus amblaiensis Speg. (**1899**) is the name given to plants which show an annulus, but this so-called annulus is nothing

more than the remnants of the volva-cap left on the stipe during elongation (FIG. 4) and soon disappears.

ACKNOWLEDGMENTS

We are under many obligations to the following for furnishing data on the specimens of *Chlamydopus* in their respective institutions: Dr. Fred J. Seaver, Mr. John A. Stevenson, Dr. David H. Linder and Dr. Lee Bonar; to the Chicago Museum of Natural History for the photograph for figure 5; to Dr. Karl P. Schmidt of the above institution for valuable data on the climate and topography of the region around Arequipa in Peru and to the National Park Service for permission to investigate the fungus flora of the White Sands National Monument.

ALBUQUERQUE, N. M., AND HOLBROOK, ARIZONA

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ADDENDA TO THE GENERA HELICOGLOEA AND PHYSALACRIA

GLADYS E. BAKER

(WITH 25 FIGURES)

Since the publication of descriptions of the genera *Helicogloea* (Baker, **'36**) and *Physalacria* (Baker, **'41**), additional material of both genera has been available for study. For each genus the geographical range of the known species is extended and new species recognized.

For *Helicogloea* the geographic range and habitats of previously known species are considerably broadened. Four species are clearly defined as new. A key to all the species is included therefore. Of the eleven species now comprising the genus all but two, *H. sphaerospora* and *H. indica,* have been seen. Descriptions of these have been taken from the original accounts (Möller, **'95** and Boedijn, **'37**, respectively). The genus falls naturally into two lines depending upon the character of the fructification, which may be of the mucous-gelatinous ("tow-like") type, or the distinctly floccose (hypochnoid) type. Other diagnostic criteria include the position of the basidial primordium which may be apical or intercalary, the character of the hypobasidial sac, the origin of the epibasidium, and the spore characteristics.

KEY TO THE SPECIES OF *Helicogloea* PAT.

1. Fructification mucous-gelatinous.....4
1. Fructification floccose, hypochnoid.....2
2. Origin of basidium (primordial cell) apical; hyphae without clamp connections or coils; spores sphaeroidal.....*H. sphaerospora*
2. Origin of basidium usually intercalary; clamp connections present; hyphae freely coiled at times; spores ovoid.....3
3. Hypobasidial sac very irregular, constricted or forked; epibasidial origin from the apex or sub-apex of the primordial cell; hyphae not coiled; spores 15–19 × 9–13 μ.....*H. pinicola*
3. Hypobasidial sac constricted but not forked; epibasidial origin usually from the apex of the sac; hyphae conspicuously coiled, especially the free ends; spores 12–15 × 7.5–9 μ.....*H. contorta*

4. Basidial origin either apical or intercalary, usually with a sac.....5
4. Basidial origin lateral on a short branch, or both apical and intercalary in the same species.....6
5. Hypobasidial sac small, under 20 μ in length, regular in form; spores ovoid, 8–12 × 5–8 μ.....*H. graminicola*
5. Hypobasidial sac larger, usually over 20 μ in length.....7
6. Basidial origin a short lateral branch; hypobasidial sac present, pendulous; spores one-celled, arcuate to crescent-shaped, 24–31 × 9–11 μ *H. indica*
6. Basidial origin both apical without a sac and intercalary with a sac; spores ellipsoidal to elongate-ellipsoidal, concave, one-, rarely two-celled, 14–24 × 5.4–9 μ.....*H. intermedia*
7. Fructification usually a thin mucous-gelatinous film.....8
7. Fructification a well-developed, irregular pulvinate mass, several mm. thick; spores subellipsoidal, often a little flattened or concave, 15–17 × 6–7.7 μ.....*H. caroliniana*
8. Basidial origin apical or intercalary; hypobasidial sac always present; spores ovoid-ellipsoidal.....9
8. Basidial origin usually intercalary; hypobasidial sac sometimes replaced by swelling of the primordial cell; spores subellipsoidal and curved, apiculus very stout, 13–15 × 4.5–7.5 μ.....*H. longispora*
9. Fructifications pallid to straw-colored; basidial origin usually apical; epibasidium primarily from the apex of the primordial cell.....10
9. Fructification a distinct yellow to orange color when dry; origin of basidium intercalary, sometimes catenulate; epibasidium primarily from the apex of the sac; spores elongate-ovoid, 16–25 × 8–15 μ.....*H. aurea*
10. Spores ellipsoidal, one-celled, 8–25 × 4–13 μ.....*H. Lagerheimi*
10. Spores ovoid, 1–3 septate, 15–18 × 7–8 μ.....*H. inconspicua*

HELICOGLOEA LAGERHEIMI Patouillard, Soc. Myc. Fr. Bull. **8**: 121. 1892.

Saccoblastia ovispora Möller, Protobasidiomyceten, Bot. Mitt. **8**: 16. 1895.

Saccoblastia sebacea Bourdot and Galzin, Soc. Myc. Fr. Bull. **25**: 15. 1909.

Saccoblastia sebacea var. *vulgaris* Bourdot and Galzin, Hym. de France, p. 5. 1928.

Saccoblastia sebacea var. *pruinosa* Bourdot and Galzin, Hym. de France, p. 5. 1928.

Helicobasidium inconspicuum v. Hoehn. (Fragm. Myk., No. 175), Sitzungsb. Akad. Wien 117, Abt. 1: 1021. 1908.

This is the type species of the genus. New materials from California and Colombia represent the first collections from those areas. Both are quite typical of the species, but that of the former collec-

tion is particularly abundant and striking. A specimen of von Hoehnel's labelled *Helicobasidium inconspicuum* shows the characteristic hypobasidia, apical germination of the primordial cell, and spores of *H. Lagerheimi* Pat., thus reducing it to synonymy with that species.

HABITAT: aspen, birch, beech, maple, pine, poplar, and various undetermined woods; humus; sawdust.

DISTRIBUTION: Brazil: Rio Grande do Sul, São Leopoldo; Ecuador: Chorrera de Agoyan near Baños; Colombia: Dept. Magdalena, Sierra Nevada de Santa Marta; Canada: Ontario; U. S.: California, Iowa, Missouri; France: Allier, Aveyron, St. Guirol, Tarn, St. Priest-en-Murat, Orne; Austria: Wiener-Wald.

SPECIMENS EXAMINED: Colombia, Dept. Magdalena, Sierra Nevada de Santa Marta, vicinity of Dos Aguas, east of Hacienda Cincinnati, elevation 1400–1500 m., August 14, 1935, *G. W. Martin 3373,* ex herb. G. W. M.; Canada, Ontario, Paradise Bay, L. Timagami, August 22, 1935, *R. Biggs 8499,* det. G. W. Martin, ex herb. U. Toronto; August 7, 1936, *R. Biggs 10520,* det. H. S. Jackson, ex herb. U. Toronto; U. S., California, Humboldt County, Little River Sand Dunes, January 2, 1940, *H. E. Parks 4,* det. G. W. Martin, ex herb. U. Cal. *640701;* Austria, Wiener-Wald, August 18, 1907, *Fr. von Hoehnel,* ex herb. von Hoehn., ex herb. Farlow.

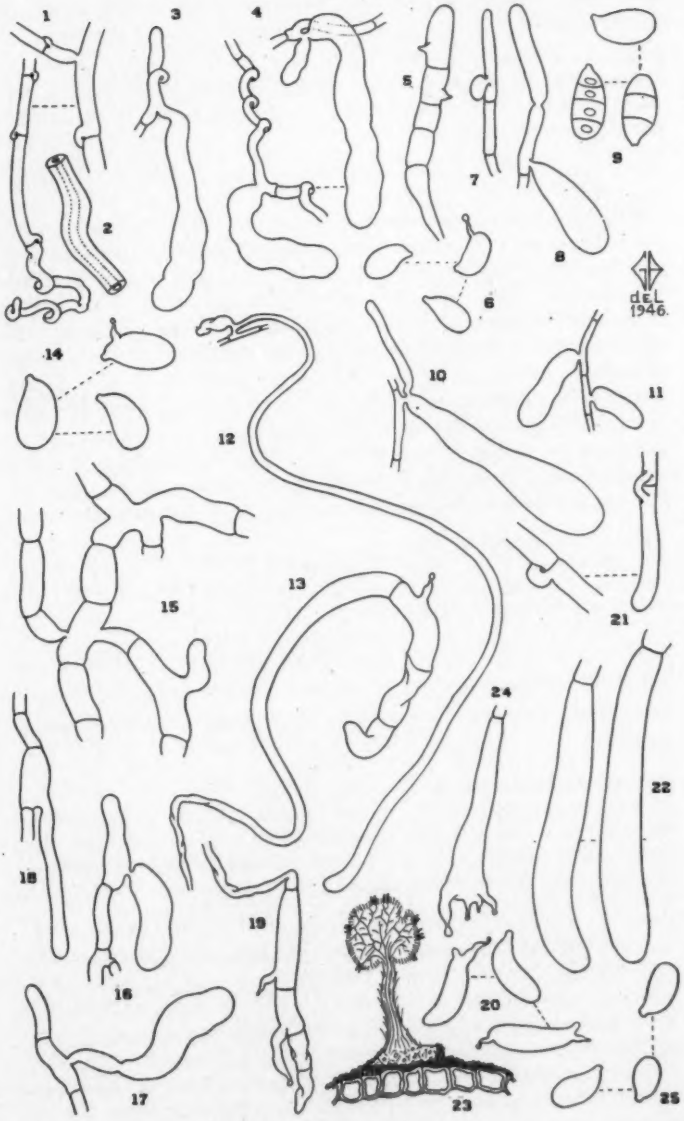
HELICOGLOEA PINICOLA (Bourd. and Galz.) Baker, Ann. Mo. Bot. Gard. **23**: 89. 1936.

Several gatherings from Canada have been studied which extend the geographical and host ranges of this floccose species. The collections are all on angiosperm substrata. Although this is not the first notation of departure from the described gymnosperm substratum that was the basis of the specific name, the collections do extend the host range considerably, further relegating the specific name to historical interest only. None of the collections is in any way atypical.

HABITAT: on decaying wood of alder, hawthorn, hazel, pine, poplar, and willow; humus.

DISTRIBUTION: Canada: Manitoba; Ontario; France: Causse Noire, Toulon; Austria: Tirol.

SPECIMENS EXAMINED: Canada: Ontario, T. F. R., Lake Timagami, Bear Island, August 30–31, 1936, *H. S. Jackson* and *R. Biggs,* in herb. U. Toronto *9507,* ver. G. W. Martin, on *Salix; R. Biggs,* August 31, 1936, in herb. U. Toronto *9508,* det. H. S. Jackson, ver. G. W. Martin, on *Corylus rostrata; H. S. Jackson,* August 12, 1937, in herb. U. Toronto *12403,* on *Amelanchier* sp.; woods east of Snell Grove, *A. J. Skolko,* May 21, 1937, in herb. U. Toronto *12404,* det. H. S. Jackson, on deciduous wood;



Helicogloea and *Physalacria*

woods west of Maple, *H. S. Jackson*, November 6, 1938, in herb. U. Toronto *13546*, on *Alnus*.

Helicogloea contorta sp. nov. FIGS. 1–6.

Fructificatione conspicua, 1 mm. crassa, floccosa, albida; hyphis 2–5 μ diam., conspicue nodoso-septatis, saepe helicoideis, muris crassis; basidiis intercalariis, saepe helicoideis; hypobasidiis non regularibus, 48–65 × 8–10 μ; epibasidiis ex hypobasidiis vel basidiis, 40–45 × 7–8 μ; sporis ovoideis, 12–15 × 7.5–9 μ.

Fructification conspicuous, up to 1 mm. thick, floccose, spreading over an area of several mm., cream-white when dry; assimilative hyphae 2–5 μ diam., with conspicuous and frequent clamp-connections, often spirally coiled, especially the free surface branches, sometimes with very thick walls; basidial primordia usually intercalary, rarely apical; primordial cell often distinctly coiled, of variable length, giving rise to the hypobasidium 48–65 × 8–10 μ, irregular, sometimes constricted but not forked; epibasidium commonly arising from the apex of the sac, but occasionally from the primordium; fertile portion 40–45 × 7–8 μ becoming 3- or 4-celled, each segment producing a single spore; spores ovoid, 12–15 × 7.5–9 μ, germinating by repetition with one or two germ tubes.

HABITAT: *Quercus macrocarpa*.
DISTRIBUTION: U. S.: Iowa, West Okoboji.
SPECIMEN EXAMINED: U. S.: Iowa, West Okoboji, July 19, 1932, *D. P. Rogers 829*, ex herb. Rogers.

This species differs from *H. pinicola* chiefly in the striking coiling of its hyphae, apical germination of the basidial primordium to the epibasidium, and the smaller size of both the epibasidium and spores.

Helicogloea longispora sp. nov. FIGS. 15–20.

Fructificatione mucedinoidea, grisea; hyphis enodosis, contortis, 2–10 μ diam., interdum crasse tunicatis; basidiis intercalariis vel apicalibus; hypobasidiis saepe constrictis, 45–50 × 9–11 μ, interdum defectis; epibasidiis 65–70 × 5–8 μ; sporis subcylindrico-fusiformibus, apiculos versus curvulis, 13–15 × 4.5–7.5 μ.

Fructification mucous-gelatinous, dull gray, inconspicuous when dry; hyphae without clamp connections, irregular, short-celled, sometimes constricted at the septa, 2–10 μ in diam. with walls of varying thickness; basidial primordia intercalary or apical; hypobasidial sac smooth, or more often once or twice constricted, 45–50 × 9–11 μ, sometimes missing and then replaced by the swelling of the intercalary primordium; usually germinating from the primordial portion; epibasidium 65–70 × 5–8 μ or more, producing

spores at ends of long filaments, 2.5–3 μ diam., spores subcylindric to fusiform, somewhat tapered at both ends and strongly curved toward the apiculus at the base, with very stout, cylindric apiculus, 13–15 × 4.5–7.5 μ, germinating by repetition with one or two germ tubes.

HABITAT: *Pseudotsuga taxifolia.*

DISTRIBUTION: U. S.: Oregon, Comstock; Lane County, Lorane.

SPECIMENS EXAMINED: Oregon, Comstock, December 11, 1937, A. M. and D. P. Rogers *478*, ex herb. Rogers; Lane County, Lorane, el. 400–500 ft., Doty *522*, ex herb. Rogers.

Several of the characters of this new *Helicogloea* are striking, namely the short-celled, contorted hyphae; the absence of hypobasidial sac at times; and the elongated, fusiform spores.

Helicogloea aurea sp. nov. FIGS. 10–14.

Fructificatione in statu vegeto gelatinosa, albida, in statu sicco membranacea, aurata; hyphis 4–5 μ diam., enodosis; basidiis intercalariis, saepe catenatis; hypobasidiis flexuosis, non constrictis, 55–75 × 12–16 μ; epibasidiis ex apicibus hypobasidiorum vel basidiis, 260–330 × 8–9 μ; sporis elongato-ovoideis, 16–25 × 8–15 μ.

Fructification when fresh gelatinous but tow-like, white; when dry membranous, golden-orange; hyphae 4–5 μ diam., without clamp connections; basidial primordium intercalary, sometimes catenulate; hypobasidium flexuous but not constricted or forked, 55–75 × 12–16 μ; epibasidium originating from the apex of the sac or occasionally from the primordial portion, very long, 260–330 × 8–9 μ, the fertile portion four-celled; spores elongate-ovoid, 16–25 × 8–15 μ, germinating by repetition with a single germ tube.

HABITAT: on decaying wood.

DISTRIBUTION: Panama, Prov. Cherique.

SPECIMEN EXAMINED: Panama, Prov. Cherique, Valley of upper Rio Cherique Viejo, 1600–1800 m., July 1, 1935, G. W. Martin *2159*, ex herb. G. W. Martin.

The extremely large size of the sac, the length of the epibasidial outgrowth, and the character of the fructification are the most outstanding features of this species.

Helicogloea inconspicua sp. nov. FIGS. 7–9.

Fructificatione tenui, sparsa, mucedinoidea, membranacea, sordide albida; hyphis 4–5 μ diam., enodosis; primordiis basidiorum apicalibus; hypobasidiis 30–52 × 8–13 μ, non constrictis; epibasidiis ex apicibus primordii, 65–115 × 5.5–8 μ; sporis ovoideis, septatis, guttulatis, 15.5–18 × 7–8 μ.

Fructification very inconspicuous, thin, gelatinous to membranous, pallid to straw-colored; hyphae 4–5 μ diam., without clamp connections; basidial primordium apical; hypobasidium 30–52 × 8–13 μ, not constricted; epibasidium originating from the apex of the primordial cell, 65–115 × 5.5–8 μ; spores ovoid, becoming one- to three-septate, often with conspicuous oil drops in the cells, 15.5–18 × 7–8 μ, germinating by repetition.

HABITAT: on decaying wood.
DISTRIBUTION: Colombia, Dept. Magdalena.
SPECIMEN EXAMINED: Colombia, Sierra Nevada de Santa Marta, Dept. Magdalena, Hacienda Valparaiso, 1200–1400 m., August 19, 1935, G. W. Martin *3533*, ex herb. G. W. Martin.

The septate spores of this species serve to separate it from *H. Lagerheimi*, which it otherwise resembles quite closely. Septate spores are unknown in all other species of the genus except *H. intermedia* where rarely they are uniseptate.

PHYSALACRIA Pk.

Two additional collections of this genus have been seen, one representing a known species and the other a new species.

Physalacria Luttrellii sp. nov. FIGS. 21–25.

Non conferta; capitulis globosis vel subglobosis, levibus, albidis vel sordide albidis, non cavis, 0.5–1.0 mm. diam.; stipite 1.0–1.5 mm. alto; hyphis nonnumquam conspicue nodoso-septatis, 2–5 μ diam.; hymenio amphigeno; cystidiis cylindricis, non incrustatis, 40–50 × 6–7.5 μ; basidiis 4-sporis, 12–15 × 7–9 μ; basidiosporis ovoideo-ellipsoideis, 8–11 × 4–5 μ.

Basidiocarps scattered, head globose or subglobose, smooth, occasionally with a few folds, white to cream-colored, not hollow, 0.5–1.0 mm. in diam.; produced on a central stalk up to 1.5 mm. high, arising from a well-developed base; in section the head filled throughout with loose reticulate hyphae; the stalk consisting of parallel, closely packed hyphae except for the basal region which is of prosenparenchyma cells covered on the outer surfaces by dark brown pseudoparenchyma cells; hyphae 2–5 μ diam., often with conspicuous clamp connections; hymenium amphigenous; cystidia large, not constricted, smooth, more or less cylindrical, projecting, 40–50 × 6–7.5 μ in diam.; basidia four-spored, 12–15 × 7–9 μ; spores ovoid-ellipsoidal, 8–11 × 4–5 μ.

HABITAT: on dead stems of *Lespedeza bicolor*.
DISTRIBUTION: U. S.: Georgia, Spalding County.
SPECIMEN EXAMINED: U. S., Experiment, Georgia, Spalding County, October 27, 1943, E. S. Luttrell *5153, type*, ex herb. Farlow.

This species possesses definite characteristics which readily distinguish it from known species and justify its autonomy. These are its smooth, globular head filled with reticulate tissue; in addition the somewhat larger basidia, the much larger cystidia, and larger spores will separate it from *P. Langloisii*. Likewise its larger basidia, less elongate in form, the type of cystidia, and spore number as well as size will separate it from *P. aggregata*.

PHYSALACRIA INFLATA (Schw.) Peck.

This species, the type of the genus, has been collected frequently in Canada and the United States, but no records outside this continent have been noted so far. A specimen collected in 1938 by R. P. Viegas at Campinas, São Paulo, Brazil, appears to be a typical representative of the species in every way except that the spores are a little small. Such a difference carries insufficient weight for specific segregation.

HABITAT: on bark.

DISTRIBUTION: North America: Canada, Ontario; U. S., Maryland, Nebraska, New Hampshire, Pennsylvania, Wisconsin; South America: Brazil, São Paulo.

SPECIMEN EXAMINED: Brazil, São Paulo, Campinas, November 21, 1938, *R. P. Viegas 2599*, ex herb. G. W. Martin.

The writer wishes to express her appreciation to Professor G. W. Martin, the University of Iowa, Professor H. S. Jackson, the University of Toronto, and Dr. D. H. Linder, the Farlow Herbarium, Harvard University, for the privilege of using the materials herein described.

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PLANT SCIENCE DEPARTMENT,
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EXPLANATION OF FIGURES

All figures were drawn with the aid of an Abbé camera lucida. The magnifications are given for each. *Helicogloea contorta:* all × 575. 1.

Hyphae with coils and clamp connections. 2. Hypha showing thick walls and small lumen. 3. Basidium of apical origin. 4. Basidia of intercalary origin. 5. Epibasidium. 6. Spores. *Helicogloea inconspicua:* all × 575. 7. Apical origin of basidium. 8. Hypobasidium and epibasidium. 9. Spores. *Helicogloea aurea:* 10. Intercalary origin of basidium, epibasidium from apex of the sac, × 550. 11. Young basidia in catenulate series, × 550. 12. Epibasidium, × 290. 13. Mature epibasidium, × 550. 14. Spores, × 550. *Helicogloea longispora:* all × 575. 15. Hyphae of short segments. 16. Apical origin of basidium. 17. Intercalary origin of basidium. 18. Intercalary origin of epibasidium without development of the hypobasidial sac. 19. Epibasidium. 20. Spores. *Physalacria Luttrellii:* 21. Hyphae with clamp connections, × 575. 22. Cystidia showing level of hymenial surface, × 575. 23. Diagram of basidiocarp in longitudinal section, × 20. 24. Basidium, × 575. 25. Spores, × 575.

SPECIES OF ASCOBOLUS FOR GENETIC STUDY

BERNARD O. DODGE AND FRED J. SEAVER

(WITH 1 FIGURE)

War conditions have focused our attention on certain mycological problems which had heretofore received little attention. For example, the destruction of the insulation used in electric equipment in the tropics has created very serious problems. The injury to lenses used in various instruments and the decay of fabrics and wood used in service equipment have also received a great deal of attention. Apparently species of undescribed fungi are often involved. The following is an illustration.

In April, 1945, Dr. George W. Martin while working with the Army Air Forces encountered a species of *Ascobolus* which developed on Japanese fabric from New Guinea. Since it seemed to differ from any of those species recorded from other parts of the world, it was referred to the junior author for study. The first specimen on fabric had been treated with a preservative and the spores were not viable. A culture was then received which was said to have been obtained from a Japanese sock. The following notes on the occurrence of the fungus were received from Dr. Martin.

"The *Ascobolus* which you have been studying appeared on a Japanese sock from New Guinea. This was one of a number of samples of captured enemy material sent in for examination, including test for cellulose-rotting organism. All samples were carefully sealed in glassine envelopes in the field and were opened in the laboratory using aseptic precautions. The surface of the envelope and the glass table in which the operations were performed were swabbed with formalin, all scissors, forceps etc. were flamed and the operations were performed in a closed chamber in which a sterilizing lamp was burning when it was not in use.

"The socks themselves had never been worn but were from a case which had been broken open by shell-fire. Isolations were made on

various media and pieces of the fabric were placed in Petri dishes and wet with a nutrient salt solution lacking carbon. It was on such pieces that the *Ascobolus* appeared in nearly pure culture. The piece sent to you was a transfer from such a growth to a piece of heavy duck, sterilized and wet with the same salt solution. The origin of the socks, of course, is unknown."

This fabricolous *Ascobolus* proved to be of special interest from a taxonomic viewpoint. It seems to possess, along with those features characteristic of *Ascobolus,* some characters that would suggest placing it in the genus *Saccobolus.* Since the ascospores very often appear as separate units in the ascus from the time of their delimitation until they are discharged, the species clearly belongs in *Ascobolus.* Even when the eight spores are clumped together in the ascus and are discharged in a tight clump, characters of *Saccobolus,* the spores are easily separated if a drop of water is added and the clump is lightly touched with a needle. When the fungus fruits abundantly in a plate culture so that a spore-print forms on the cover where water of condensation is apt to collect, the ascospores will seldom be found adhering tightly together in clumps of eight (FIG. 1). The eight spores of a true *Saccobolus* are separated only with some difficulty and then they are usually broken or injured. Boudier (**1877**), as will be noted later on, pointed out that in some respects *Ascobolus pusillus* is much like a *Saccobolus,* but since the spores are free in the ascus it must be an *Ascobolus.*

An account of the culture work carried on with this fungus and a brief consideration of species of the group as suitable for mycogenetic studies follow the formal description of this species as given below.

Ascobolus saccoboloides Seaver, sp. nov.

Apotheciis sparsis vel gregariis vel confluentibus, sessilibus, pallide flavis. vix 1 mm. diam.; hymenio convexo; ascis late clavatis, 8-sporis, stipitatis, 150 × 20 μ; sporis ellipsoideis, violaceo-fuscentibus, subconglutinatis dein dispersis; paraphysibus filiformibus.

Apothecia scattered or gregarious, often confluent, sessile, pale yellowish amber in color, less than 1 mm. in diameter, hymenium convex, dotted over with the protruding asci; asci broad-clavate, reaching a length of 150 μ and a diameter of 20 μ, attenuated below

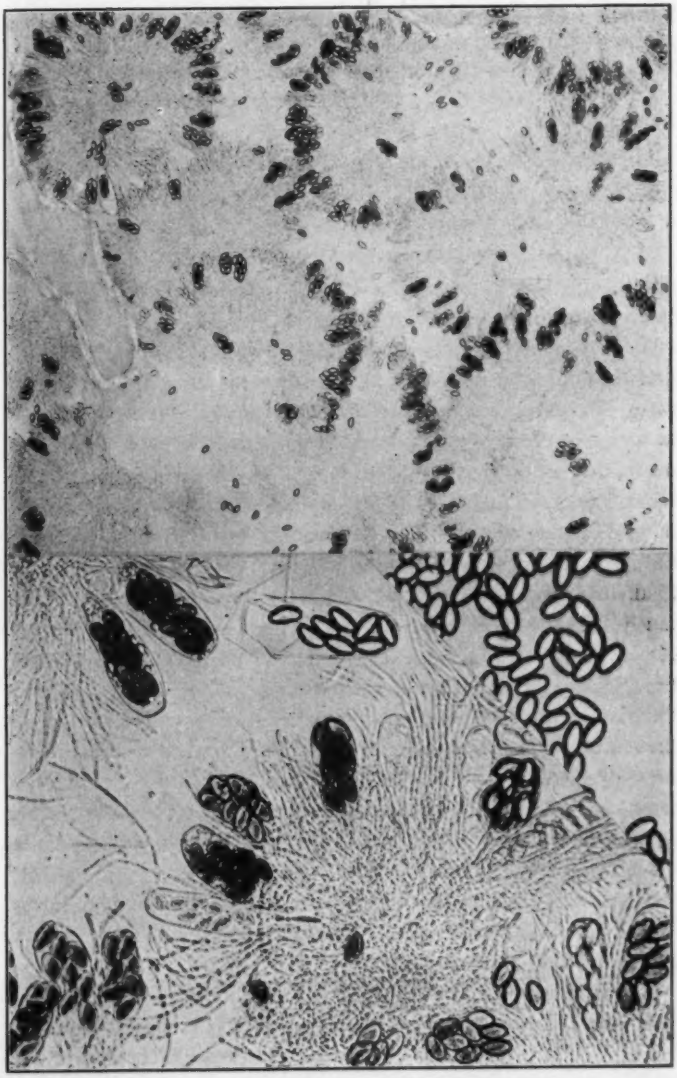

FIG. 1. *Ascobolus saccoboloides*. Above, an apothecium crushed to show asci and spores. Below, portion of same enlarged.

into a slender stem-like base, 8-spored; spores clinging together in the ascus *Saccobolus*-like, often discharged together, finally separating, at first hyaline becoming purple then brown, ellipsoid, about $10 \times 16\,\mu$, smooth or very minutely roughened; paraphyses very slender.

On Japanese fabric from New Guinea.

CULTURE WORK

The culture of *Ascobolus saccoboloides* sent us by Dr. Martin was developing large numbers of apothecia (ascocarps) when received. When transfers were made to a potato-dextrose agar medium good mycelial growth was obtained but apothecial development was long delayed and often no apothecia were ever developed. On a peptone-yeast medium which Dr. W. J. Robbins has found very satisfactory for certain types of work on antibiotics, growth was vigorous but no ascocarps ever developed on any of the twelve cultures which have been made. The mycelium grew fairly well on a horse-dung-decoction agar medium, but fruiting was very unsatisfactory. On sterilized horse dung growth was slow but numerous ascocarps finally matured. It was found that a malt extract agar medium was much better suited for ascocarp development. When culturing *Ascobolus Winteri*, Dodge (1912, fig. 2, p. 181) found that although that fungus would grow over large colonies of certain contaminating bacteria, bacteria of another type acted to oppose or prevent growth of the *Ascobolus*. It was found that certain colonies of soil bacteria that had become established in some of our plate cultures that had been opened several times for study, served to stimulate the formation of fruit bodies of *A. saccoboloides*. In some cases a half dozen or more apothecia matured on the bacterial growth while no apothecia were present on the agar in the vicinity of the bacterial colony. No work was done to discover the reason for this phenomenon.

The mycelial hyphae are very fine or thin and branching is rather profuse. Growth is slow as compared to that of many species of *Ascobolus*. While chains of swollen cells resembling spores (or perhaps young ascogonia) were sometimes found on fluffy surface growth no true oidia or other sexual propagating bodies were noticed in our cultures. Large numbers of spirally coiled structures

with free tip ends are often present in the primordial growth. Because the ascocarp primordia are very small we have not attempted to make a study of their nature so we do not know whether or not antheridia and ascogonia take part in reproduction. We were especially interested to determine whether the species might be heterothallic because heterocaryosis and hybridization in fungi are topics much in the minds of many who are are concerned with a study of nutrition, general physiology and development of new races of fungi, especially as bearing on the questions of antibiotics and genetics.

At first, we had some difficulty in inducing the ascospores to germinate. On horse-dung-decoction agar germination was so long delayed and the growth of germ tubes so slow that the plates became contaminated from being opened frequently in searching for germinated spores. It was therefore decided to try the single hyphal tip method although we realized that this method has its limitations. The fact that all single tip cultures of an Ascomycete fruit does not prove that the fungus is homothallic.

Single tip cultures. Since the mycelium seems to prefer to grow largely on the surface it was not difficult to isolate some two dozen single tips and grow them in tubes of malt extract agar. In due time every one of the cultures developed many ascocarps. In earlier years such evidence would have been accepted as proof of homothallism. A high percentage of single-tip cultures from wild type mycelia of *Neurospora tetrasperma* (Dodge, 1928), would produce ascocarps just as though the species were homothallic. When we see that the mycelium is heterocaryotic, the cells usually carrying two kinds of nuclei as to their mating types, we know that the species is not really homothallic; it is heterothallic, or, at least, facultatively heterothallic. To avoid all uncertainty it was therefore necessary to obtain numerous cultures from single ascospores.

Single-ascospore cultures. After experimenting with heat-treatment of ascospores and having found this ineffective, we tried several different kinds of media. Occasionally a few spores germinated after several days. The spores are rather small and the germ tubes are very thin and so very difficult to locate without contamination of the plates. We found that excellent germination could be obtained when ascospores were sown on the surface of

an agar medium which Miss Grace Antikajian is using in her work on *Ascobolus magnificus*. This is made up with a dung decoction to which either whole yeast or yeast extract is added. It was a simple matter to sow ascospores on the surface of this Antikajian medium in plates. A high percentage of germination was observed on the third day. Fifteen single spores bearing germ tubes were transferred to tubes of potato-dextrose agar. Two days later when mycelial growth had become well established on the slants, the original bit of agar bearing the germinated spore in each case was picked out and transferred to a tube of malt extract agar. Good growth was made in all thirty cultures. At the end of six weeks there was no evidence that ascocarps were forming in any of the potato-dextrose cultures. Mature ascocarps had developed in all fifteen malt extract cultures by the end of the third week. *Ascobolus saccoboloides* is therefore homothallic. In three cultures mature spores could be seen on the tenth day. These were the cultures in which large blocks of the dung-decoction yeast-extract medium had been transferred with the germinated spore. At first the ascocarps all developed on the malt extract agar in the tube and not on the dung-yeast block of agar. In Petri-dish cultures with the dung-yeast extract medium no ascocarps could be found at the end of three weeks, but in transfers from such plates to tubes of malt-extract agar ascocarps were forming by the fifth day. From this it is clear that although the yeast extract certainly stimulates spore germination and vegetative growth, it is not favorable for ascocarp development in this case. There was great variation in the times required for the appearance of the mature spores. The first ones were found in a few ten-day-old cultures, but in other cultures mature spores could not be found until after three weeks.

We have not made a study of the method of origin of the ascocarps except to learn, as noted above, that the apothecial primordia are very small and that they occur more or less in clusters or groups. That is, a single ascocarp has its origin in several ascogonia which arise from the surface of the medium and are so close together that the mature ascocarps coalesce giving the appearance of a continuous, though bumpy, hymenial layer. Ascus formation is much delayed where there is extensive coalescing of apothecia. Where the ascocarps are well separated one can often see that the hymenium is

marked off in a way that indicates that ascogenous hyphae have arisen from different ascogonia. Green (**1931**) and Gwynne-Vaughan and Williamson (**1933**) have shown that several ascogonia are present at the origin of individual ascocarps of *Saccobolus obscurus* and *S. depauperatus*.

The apothecia are at first pale amber. Later in old cultures they become dark amber and are spotted purple by the clumps of mature ascospores. In many species of *Ascobolus*, particularly the kinds that have a broad hymenial layer, the spores are usually discharged more or less simultaneously in small "clouds." When watching such a spore discharge one can observe how the hymenial surface changes quickly from dark purple to a greenish color. The spores of *Ascobolus saccoboloides* are not discharged in such clouds. In fact mature apothecia are usually spotted with spore-bearing asci in which the clumps of spores are retained a long time. (FIG. 1). Crushed mounts can be photographed readily. There is no movement such as is apt to occur in mounts of other speciees when spores are discharged. In other words the hymenium is rather "sticky."

GENERAL CONSIDERATIONS

All species of Ascobolus not coprophilous. Many botanists think of species of *Ascobolus* as belonging to that group of fungi which grow on dung of various animals. No one in recent years has monographed the Ascobolaceae so that we have no reliable source of information on just how many good species of *Ascobolus* there are. Rehm (**1896**) recognized twenty-two species, excluding varieties, as occurring in central Europe. Of these thirteen were recorded as coprophilous and nine as non-coprophilous. Seaver (**1928–1941**) in his North American Cup-fungi recognized sixteen species of *Ascobolus*, of which nine are coprophilous and seven non-coprophilous. *A. saccoboloides* is a good example of a species which grows well on fabric. We should add two more species to Seaver's list of the non-coprophilous species. *A. pusillus* Boud. was collected on old burned ground during three different summers at White Post, Virginia. Although its habitat and spore markings are much the same as those of *A. carbonarius* it is a distinct species (see Dodge, **1921**, pl. 10, fig. 8). He studied spore

germination and found that "heat treatment" which had proved so effective in inducing germination of spores of *A. carbonarius* was not effective with spores of *A. pusillus*. A good slide mount of this species will be found in the herbarium of the New York Botanical Garden. This mount shows great variation in size and aspect of the spores as was noted by Boudier in Icones Mycologiceae (pl. 412 f. a-i). That author (**1877**) pointed out that the paraphyses are much like those of a *Saccobolus* and it is otherwise also much like a *Saccobolus* except that the spores are free in the ascus. *A. saccoboloides* is even more like a *Saccobolus*. Yet the presence of free spores in asci relates it more to *Ascobolus*.

A. viridis Curr. var.? as reported and figured by Dodge (**1912**) was very commonly found on black muck soil under alder (*Alnus*) bushes at "Springside" near Hackensack, New Jersey. It is a rather large pale greenish species. Its ascospores are the same shape as those of *A. viridis* Curr. but they are smaller. The spore markings are much the same. Ascospores of *A. geophilus* are elliptical with well-rounded ends whereas those of the American *A. viridis* are rather pointed (see Seaver, **1928**, pl. 7, fig. 2 and Dodge, **1912**, pl. 10, fig. 2–4). Dodge reported that he had difficulty in germinating spores of his *A. viridis* and heat-treatment also was not effective. Betts and Meyer (**1938–1939**) found that ascospores of *A. geophilus* Seaver germinate readily without any special treatment whatsoever. This fact alone would serve to distinguish *A. viridis* var. from *A. geophilus* with which, because of its habitat, it might be confused. Counting then *A. pusillus* and *A. viridis* Curr. var.? Seaver would have nine coprophilous and nine non-coprophilous species of *Ascobolus* for America. Grelet (**1944**) reports twenty-one species of *Ascobolus* in France. Of these only eleven were coprophilous.

Heterothallism in Ascobolus. Following the report (Dodge, **1920**) that *Ascobolus magnificus* is heterothallic, Betts (**1926**) proved that *A. carbonarius* is also heterothallic. The latter species (see also Betts and Meyer, **1941**) would certainly furnish excellent material for genetic studies. As a rule all eight spores from an ascus will germinate following heat-treatment. It has numerous distinct morphological characters which would serve well for genetic work.

Ames (**1930**) recorded *A. stercorarius* as "hetero-homothallic." "Single spore cultures of this species gave rise to a few apothecia." He found, however, that by mating certain single spore mycelia in culture he could obtain a much larger number of apothecia.

Green (**1931**) reported on her culture work with *A. stercorarius, A. glaber, Dasyobolus* (*Ascobolus*) *immersus* and *Saccobolus obscurus*. Certain cultures of *A. stercorarius* obtained from single ascospores finally, after several months, produced ascocarps. This would ordinarily suggest that the species is homothallic. She found, however, that other single-spore cultures remained sterile. These strains, she proved, were of two kinds such that members of her group **A** fruited rather quickly with any member of her group **B**. This behavior suggested that the species might be heterothallic and not homothallic. Dowding (**1931**) proved that *A. stercorarius* is in fact strictly heterothallic. She showed how any fruiting of what were supposed to have been single-spore mycelia, such as reported by others previously, was probably due to the transfer of oidia of one sex to a mycelium of the opposite sex by mites or other means of contamination.

Betts and Meyer (**1938, 1939**) proved by careful culture studies that *A. geophilus* Seaver is heterothallic.

Although both Ames (**1930**) and Green (**1931**) found that the few single-spore cultures of *A. immersus* which they were able to obtain did not produce apothecia, Rizet (**1939**) was the first to report culture experiments which actually proved that the species is heterothallic. Rizet says that he obtained a number of cultures derived from single ascospores and in each case ascogonia were formed but no ascocarps with spores ever developed. A number of these cultures produced microconidia. By mating these self-sterile unisexual strains in various combinations he proved conclusively that *A. immersus* is heterothallic. One of his matings, No. 4–No. 15, was especially interesting because the F_1 asci matured spores of two kinds as to their color, four being normal and purple, the other four were colorless and sometimes smaller. Rizet proved that this segregation four and four for color was not an indication of sex or of mating type because in some asci the colored spores were of one sex while in others the colored spores were the opposite sex. When he mated two races derived from colored spores, all

eight spores in the F_1 asci were colored. In matings of races derived from colorless spores the F_1 asci all had eight colorless spores. Rizet had not seen Zickler's (**1934**) paper in which that author had earlier found a similar segregation in asci of *Bombardia lunata*.

Rizet has reported another case where he had mated race No. 25, derived from a colorless spore, with race No. 34, derived from a colored spore. The spores in the F_1 asci were all colorless. He attributed this unilateral segregation to the effect of hormone action such as had been reported by Moreau and Moruzi for *Neurospora*. Rizet did not carry out this highly interesting experiment to its logical conclusion. He did not say whether or not the eight spores in such asci were all of the same sex. Until better proof is forthcoming we may be pardoned for not being wholly convinced on this point. Where a species like *A. immersus* produces many microspores one should be on the watch for contaminations by these minute spores. If he used the heat-treatment method to induce ascospore germination the microconidia carried over accidentally would be killed, but this would not prevent cross fertilization by microconidia later on. Moreau and Moruzi, Lindegren and Rizet all seem to believe that diffusible hormones are responsible for this unilateral fruiting, but little evidence has been furnished to prove this to be a fact, plausible as Lindegren's (**1934**) explanation might at first seem to be. It ought to be comparatively easy to filter out these hypothetical "hormones" from broth cultures and apply them to the "self sterile" mycelia and make them fruit. *Ascobolus immersus* is world wide in its distribution and it can be found on dung in almost any pasture during the summer. It should be, as Rizet says, an excellent species with which to work genetically.

We have, therefore, in America at least five heterothallic species of *Ascobolus*, namely *A. magnificus*, *A. carbonarius*, *A. stercorarius*, *A. geophilus*, and *A. immersus*. Excepting perhaps the first named, *A. magnificus*, a high percentage of the ascospores can be induced to germinate. Spores of *A. geophilus* grow readily without any special treatment whatever. Spores of *A. carbonarius* and *A. immersus* respond very satisfactorily to heat-treatment but those of *A. stercorarius* respond less satisfactorily. All five species have good morphological characters and are widely distributed in this

country. Certain principles of inheritance are much more clearly expressed by these haploid organisms than they are in diploid plants and animals. For this reason as is abundantly evident from the work of Lindegren, Beadle, and others, such haploid organisms as species of the Ascobolaceae should be thoroughly investigated genetically if found to be heterothallic.

Homothallic species. Although the ascospores of *Ascobolus Winteri* readily germinate when given the heat-treatment (Dodge, **1912**) he made no statement as to single spore cultures producing ascocarps. He has always assumed, however, that *A. Winteri* is homothallic. This point should be cleared up by adequate culture studies with single ascospores. This species has been very commonly found on goose dung.

Schweizer (**1923**) described the development of a new species, *Ascobolus citrinus.* No antheridia were discovered. His report on his culture work does not indicate whether or not the species in homothallic. Later (**1931**) he does prove that *A. strobilinus* is homothallic. Whether or not *A. glaber* and *Saccobolus obscurus* are homothallic, Green (**1931**) does not say definitely.

Gwynne-Vaughan and Williamson (**1933**) state that they grew in culture a number of species of the Ascobolaceae and made some preliminary observations on their development. "As it happened," they say, "all proved to be homothallic." Among those studied were *Ascobolus viridulus, A. Leveillei, A. equinus,* and *Saccobolus depauperatus.* It is not clear whether they intended to include in the list of homothallic species *A. stercorarius* (*A. furfuraceus*) and *A. immersus.* Probably they did not for as noted above they are both strictly heterothallic.

The ascocarp of the following species has been proved to originate normally from a single ascogonium: *A. stercorarius, A. immersus, A. citrinus, A. Winteri, A. viridulus, A. equinus, A. Leveillei;* from a single pair of sex organs: *A. magnificus, A. carbonarius.*

The ascocarp of the following species has been reported to arise from a number of pairs of ascogonia and antheridia: *A. strobilinus, Ascophanus aurora, Ascodesmis microscopica* (*nigricans*). Ascocarps of *Saccobolus depauperatus, S. obscurus* and *Ascobolus saccoboloides* are known to have several ascogonia at their origin, but no one has reported that antheridia are also present.

Those who still hold that there occur two successive nuclear fusions followed by a double reduction in the life history of an individual Discomycete could very easily settle this question by a genetic study of species *Ascobolus*. With only a single nuclear fusion and that one in the ascus, there can normally not be more than four genotypically different kinds of ascospores in an ascus. If the spores are disposed or arranged in a definite line in the ascus, they will be found to alternate four and four, two and two, or two four two for any pair of genetic factors. With a double fertilization and double reduction one should find many asci with eight different kinds of spores, and if the spores are in linear arrangement they should very frequently alternate one and one for members of a pair of factors, such, for example, as mating type factors. Betts and Meyer (**1939**, **1941**) state that the spores in asci of *Ascobolus geophilus* and *A. carbonarius* were arranged four and four or two and two for the sex factors in the asci they analyzed. The number of asci analyzed was perhaps not large enough to be fully convincing to those who hold to the double fertilization theory. If we add *A. immersus* we would have three species readily available and well adapted for genetic studies. Of course best of all would be *A. magnificus* and *A. stercorarius* if one could find a better way of inducing a high percentage of spore germination. The former species has an interesting *Papulaspora* asexual stage while the latter produces many microconidia when properly grown.

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POLYPORUS GUTTULATUS AND PTYCHOGASTER RUBESCENS [1]

ROSS W. DAVIDSON, CLYDE M. CHRISTENSEN, AND ELLIS F. DARLEY *

(WITH 3 FIGURES)

DISTRIBUTION OF POLYPORUS GUTTULATUS

Peck (**14**, **15**) described *Polyporus guttulatus* Pk. (*P. maculatus* Pk.) from sporophores collected in New York about 1872. Lloyd (**5**) considered Peck's fungus to be the same as *P. alutaceus* Fr. of Europe, stating, "This species grows on pine and is rather rare both in Europe and the United States." He recorded a specimen from New York (**6**) and one from Michigan (**7**). Overholts (**10**) considered it rare on wood of coniferous trees in Ohio and later (**11**) listed it from Michigan and Wisconsin. He stated (**12**) that it is frequent on dead wood of coniferous trees. Lowe (**8**) also considered it "frequent" on wood of coniferous trees and doubtful on beech. Newman (**9**) recorded it as common in northern Wisconsin on pine and hemlock stumps and logs. Shope (**17**) did not include it among his Colorado polypores, but it was collected in the Great Smoky Mountains in Tennessee by Kauffman (**4**) although the kind of wood on which it was growing was not stated. Overholts collected it on fallen *Abies balsamea* (L.) Miller in New Hampshire (**13**), and Zeller (**19**) reported it on oak from Oregon. The following specimens of *P. guttulatus* and *P. alutaceus* Fr. are in the mycological collections of the Bureau of Plant Industry, all of them collected from dead wood.

[1] Cooperative paper of the Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Beltsville, Maryland, and Division of Plant Pathology and Botany, University of Minnesota, St. Paul, Minnesota. Paper No. 2287 of the Scientific Journal Series, Minnesota Agricultural Experiment Station.

* The writers wish to thank N. E. Borlaug for assistance in certain phases of the work.

Pinus sp. Star Lake, Wis., 1904, coll. *R. A. Harper, 190;* Hunt Co., Pa., July, 1936, *W. A. Campbell* & *L. O. Overholts* (*F.P. 71143*); Neebish Island, Mich., Aug., 1899, *E. T. Harper* (*F.P. 20702*).

Pinus contorta Dougl. ex. Loud. Bonner Co., Idaho, Aug., 1920, *J. R. Weir, 15110* and *15352.*

Pinus monticola Dougl. ex D. Don. Priest River, Idaho, 1912 and May, 1915, *J. R. Weir, 1285;* in Canada near Metaline Falls, Wash., *J. R. Weir, 2123;* another collected in Idaho in 1926, *J. H. Rust, 1121.*

Pinus ponderosa Lawson. Crater Lake, Oregon, Sept., 1916, *J. R. Weir, 8697.*

Larix occidentalis Nuttall. Coolin, Idaho, Sept., 1910, *G. G. Hedgcock* (*F.P. 4708*); Halfway House, Idaho, Aug., 1911, *G. G. Hedgcock* & *J. R. Weir* (*F.P. 11009*); Coolin, Idaho, Sept., 1919, coll. *J. R. Weir, 11327.*

Picea glauca (March) Voss. Lake Timagami, Ontario, Sept., 1918, *J. H. Faull, 3186;* Hayward, Wis., Oct., 1919, *C. J. Humphrey, 9897.*

Picea mariana (Mill.) B. S. P. Carry Pond, Me., Aug., 1920, *P. Spaulding* (*F.P. 38115*).

Tsuga heterophylla (Raf.) Sargent. Bonner Co., Idaho, Aug. 12, 1920, *A. S. Rhoads* (*J. R. Weir 15235*), also in U. Idaho Forest Path. Herb. *3517;* Leu Boehls, Idaho, Aug., 1923, *C. R. Stillinger, 944.*

Pseudotsuga taxifolia (Poir.) Britton. Douglas, Ariz., Sept., 1908, *H. D. Burrall* (*F.P. 1141*); Olympia, Wash., Oct., 1909, *C. J. Humphrey* (*F.P. 6011* and *6012*); Stonewood, Wash., Sept., 1910, *C. J. Humphrey* (*F.P. 6301* and *6302*); Bellingham, Wash., Sept., 1916, *J. R. Weir, 8017;* Detroit, Oregon, Oct., 1909, *G. G. Hedgcock* (*F.P. 1754*).

Abies balsamea (L.) Miller. Hebron, N. H., Aug., 1905, *Percy Wilson.*

Abies grandis (Dougl.) Lind. Bark Camp, Idaho, July, 1925, *J. R. Stillinger.*

Thuja plicata D. Don. Priest River, Idaho, 1915, *J. R. Weir, 4733.* (Also in U. Idaho For. Path. Herb. *3529.*)

No host was mentioned for other specimens, including several from New York and several from Wisconsin. All of the Forest Pathology (F. P.) specimens were identified or verified by L. O. Overholts and most of the others were identified by J. R. Weir, A. S. Rhoads, C. G. Lloyd, and W. A. Murrill. The C. G. Lloyd Herbarium has a number of specimens under the name *Polyporus alutaceus* but hosts are not listed for any of them.

J. R. Hansbrough supplied data on thirteen sporophore specimens in the New Haven, Conn., Forest Pathology branch office herbarium. Most of them were collected in the New England States. The hosts with number of collections from each are as follows: *Acer rubrum* 1, *Abies balsamea* 4, *Picea mariana* 1, *Picea rubens* 6, *Tsuga canadensis* 1. G. H. Englerth sent information on four specimens in the Madison, Wis., Forest Pathology Herbarium, all

of which were collected by Hubert in Minnesota. Three were on windfall trees.

These specimens and literature references show that *Polyporus guttulatus* is distributed throughout the northern tier of States and in Canada where its host trees occur, and may extend southward into the Great Smoky Mountains.

POLYPORUS GUTTULATUS FROM BUTT ROT OF CONIFERS IN MINNESOTA

From 1935 to 1939 Christensen found *Polyporus guttulatus* fruiting on six trees or stumps in and near Itasca Park, Minnesota. Overmature and wind-thrown trees of coniferous species native to the area are rather abundant there. The fact that the fungus was found on only six different individuals during the five years, even though it was sought from late July to early September each year, suggests that in the area observed sporophores of the fungus are relatively rare. Three of the six trees on which the fungus was found were black spruce (*Picea mariana*), two were balsam fir (*Abies balsamea*), and one was Jack pine (*Pinus banksiana* Lamb).

Approximately thirty fruit bodies were found on the stump of a recently wind-thrown black spruce, Aug. 23, 1938 (FIG. 1). Only a thin shell of sound wood remained in the lower trunk and in the roots as far as six feet from the base of the tree. Visible decay extended up the trunk about ten feet from the ground, and cultures of *Polyporus guttulatus* were obtained two feet beyond this, but not five feet beyond. The decayed wood when first exposed was pale brown and of uniform, cheesy texture, but later darkened and broke up into cubical fragments typical of the decay caused by *P. guttulatus*.

Twelve to fifteen fruit bodies were found near the same place on a living black spruce. Only one or two fruit bodies were found on each of the other four trees or stumps on which the fungus was collected. Cultures made from both the fruit bodies and the decayed wood served as a basis for the cultural descriptions given below.

The characters of the fruit bodies as determined from more than fifty fresh specimens collected in and near Itasca Park over a period of five years differ in some respects from the available descriptions of *Polyporus guttulatus*, and therefore it seems worth

while to summarize them, as follows: The fruit bodies are usually sessile, 6–15 cm. wide (the majority about 10–12 cm. wide), project from the wood 6–12 cm., are 1.5–4.0 cm. thick at the base, and are attached to the wood by a narrow, lateral, stemlike base. Sometimes the fruit bodies have an almost central stem, with several

FIG. 1. Fruit bodies of *Polyporus guttulatus* on *Picea mariana*. The tree had broken over because of decay by this fungus.

semicircular or nearly circular shelves coming out at different levels, but this is exceptional and occurs only when the fruit body arises from a root beneath the surface of the ground. The upper surface at first is white or nearly so, usually slightly rough or pitted, and covered with fine, short mycelia. It slopes down from the margin to the point of attachment, thus being shallow funnel-shaped. Usually there are three to five broad, inconspicuous concentric

ridges on the surface, indicating the periods of growth during the formation of the fruit body. Sometimes these ridges are pale reddish-brown. Faint, narrow, radial ridges often are present also. The surface of fruit bodies formed on recently dead or dying trees may become covered with insect frass and debris from the wood-boring and bark beetles that infest these trees, and the fungus often grows over and incorporates this debris in the surface, causing it to be rough. Some old fruit bodies are almost uniformly reddish-brown on top. The context is 1–4 cm. thick at the stemlike base, 2–3 mm. at the margin, white, obviously fibrous, and the fibers extend radially and slant up from the central plane toward the upper surface and downward toward the pores. The context is firm but fairly brittle when fresh, and without obvious growth zones. The pores are 4–9 mm. long at the place of maximum length, and disappear at the margin. They are 40–50 per cm., uniform in diameter throughout the fruit body, oval, circular or irregularly circular in cross section, and the walls are rounded at the open end and about as thick as the diameter of the pores. The pores are pale yellow inside and in fresh specimens become pale reddish-brown when bruised. Sometimes the pores are in two or three rather definite, separable layers, each layer 2–3 mm. long, and probably formed during a separate growth period. When young and growing in a humid atmosphere the fruit bodies exude a clear liquid in drops all over the surface. Fresh fruit bodies have a faint, but definite and rather sweet odor. The microscopic characters of the fruit bodies examined did not differ from those described by Lowe (8) and hence will not be given.

Two roots, each 1–2 inches in diameter on each of twenty black spruce trees (ten of the trees were in an arboretum and were approximately twenty years old, and ten were in a forest near where fruit bodies were found on a wind-thrown tree), were inoculated with *Polyporus guttulatus* in 1938. A hole was bored almost through the root, about two feet from the trunk, with an increment borer, context and pore tissue from fresh fruit bodies were inserted into the hole, and the hole was plugged with a tight peg of black spruce wood. In most cases the peg was tight enough to split the root slightly. On one root of each tree, checks were made by boring a hole and putting in a plug. When last examined, in

1943, five years after inoculation, there was no visible decay in any of the inoculated roots. Although few conclusions can be drawn from such negative evidence, this does at least suggest that *P. guttulatus* does not enter readily through root wounds, although such observational evidence as is available on the decay caused by *P. guttulatus* in living trees uniformly indicates that the decay begins in the roots.

PTYCHOGASTER RUBESCENS

Ptychogaster rubescens Boud. was described first in Europe (**1**) and is known only in its conidial stage, which occurs on coniferous wood. Many herbarium specimens of *Ptychogaster* have been examined and some of those identified as *P. albus* Corda by various collectors are very similar to the *P. rubescens* of this report. One of these, in the C. G. Lloyd Herbarium (*55333*) from Belgium (ex herbarium of E. Bommer and M. Rousseau *10664*), is a mass of light purple-brown spores, 2–3 cm. across, intermixed with spruce twigs and needles. Spores are almost smooth, light brown, and 6–9 μ long, which is about the size of spores produced in cultures observed by the writers. A note with this specimen states, "common on logs and trunks of conifers lying on the ground." Most of the specimens of this type are from Europe, but one in Lloyd's Herbarium (*55335*) is somewhat similar to *55333* and was sent by D. W. Weiss (*57*) from Massachusetts. Another Lloyd specimen (*55510*) was found by R. H. Dennenston on soil at Madison, Wis., in October, 1902. Many of the specimens listed under the name of *Ptychogaster albus* have smaller spores, with walls slightly roughened, and many have hyaline conidia that may be immature or developed under conditions of temperature and moisture that prevented expression of typical characters. However, specimens with consistently smaller, light brown spores, or those with rough-walled spores probably are not at present referable to *P. rubescens*.

Bourdot and Galzin (**2**) list several European polypores (*Leptoporus albidus* (Schaeff. ex Fr.) Bourd. & Galz., *L. destructor* (Schrad.) Bourd. & Galz., and their various forms) with conidia somewhat like those of *Polyporus guttulatus* and *Ptychogaster rubescens*, but without a much more extensive study and comparison of cultures from these European species of *Polyporus* it is impos-

sible to determine whether they are related closely to those herein described.

CULTURAL CHARACTERISTICS

Cultures from the fruit bodies of *Polyporus guttulatus* found in Itasca Park were sent to Ross W. Davidson for identification in 1936, 1937, and 1938. In 1939 a fungus isolated from a typical sporophore of *Ptychogaster rubescens* on cypress wood from a greenhouse bench in St. Paul was also sent to Davidson for identification and was found to resemble closely the cultures of *Polyporus*

TABLE 1

GROWTH AND REACTION OF *Polyporus guttulatus* AND *Ptychogaster rubescens* ON MALT, GALLIC ACID, AND TANNIC ACID MEDIA

Fungus	Culture Number	Diameter Growth in Millimeters					
		On Malt Agar		On Gallic Acid[a]		On Tannic Acid[a]	
		7 days	14 days	7 days	14 days	7 days	14 days
Polyporus guttulatus	638 (Mounce)	8	50	21	55	0	0
do	71286	8	40	11	42	0	0
do	71799	8	35	16	40	0	0
Ptychogaster rubescens	C.B.S.	44	90+	27	58	tr	tr
do	Minn.	46	85	29	52	0	0
do	970 Idaho	44	90	25	56	0	0

[a] All cultures had a 0 reaction on gallic acid and tannic acid media and all belong to the growth and reaction group 3 described by Davidson, Campbell, and Blaisdell (3).

guttulatus. In 1941 a similar culture was obtained from Baarn, Holland, under the name of *Ptychogaster rubescens* Boud. (18). An additional culture of a conidial fungus was isolated from brown rot in cedar poles at Moscow, Idaho, by Ehrlich. The fact that these several isolates were obtained from wood products suggested that a more thorough study was necessary to determine the relationships of the isolates from various sources.

Cultures of *Polyporus guttulatus* are consistently slower growing (Table 1 and fig. 2) than the cultures of *Ptychogaster rubescens* from Holland, from the greenhouse bench in St. Paul, and from a

cedar pole in Idaho. They do not develop so large and coarse a mass of mycelium and spores. Cultures from both fungi are white at first and after about a week become colored by the mass of conidia that develop on the mycelia (FIG. 2). *P. guttulatus* also has a slightly lower temperature optimum (Table 2). These differences are well illustrated by Tables 1 and 2 and Figures 2 and 3.

Ptychogaster rubescens develops more color, probably because of the greater mass of mycelium and spores. On two per cent malt agar in diffused light cultures become "vinaceous-buff" [2] or "salmon-buff" to "cinnamon-drab." Old test tube cultures are "cream buff" to "cinnamon-buff." Cultures of *Polyporus guttulatus* do not color up so quickly, and the color is more variable, apparently being more sensitive to room temperatures than those of *Ptychogaster rubescens*. Cultures of *P. guttulatus* one to two weeks old in diffused light are white to "ivory-yellow" to " cream-buff" and old test tube cultures are "light vinaceous-fawn" to "fawn-color." The colors of both fungi are slightly darker when grown on malt agar containing 0.5 per cent gallic acid, and both fungi give a negative oxidase reaction that indicates that they cause a brown, carbonizing rot. Cultures of both have abundant clamp connections.

TABLE 2

DIAMETER GROWTH OF *Polyporus guttulatus* AND *Ptychogaster rubescens* AT FIVE DIFFERENT CONSTANT TEMPERATURES IN THE DARK

Fungus	Culture Number	14° C.		22° C.		26° C.		32° C.		35° C.	
		7 days	14 days	7 days	14 days	7 days	14 days	7 days	14 days	7 days	14 days
Polyporus guttulatus	(Mounce) 638	18	50	33	82	17	71	0	0	0	0
do	7286	14	34[a]	29	66	20	50	0	0	0	0
do	71799	13	33[a]	24	65	21	49	0	0	0	0
Ptychogaster rubescens	C.B.S.	17	49	33	90[a]	40	90[a]	13	22	0	0
do	Minn.	16	45	38	87[a]	43	90[a]	24	39	0	0
do	970 Idaho	14	44	35	89[a]	44	90[a]	16	38	0	0

[a] Trace of pink appeared in the white mycelium.

Conidia formed by *Ptychogaster rubescens* are hyaline to light

[2] Colors in quotes according to Ridgway (16).

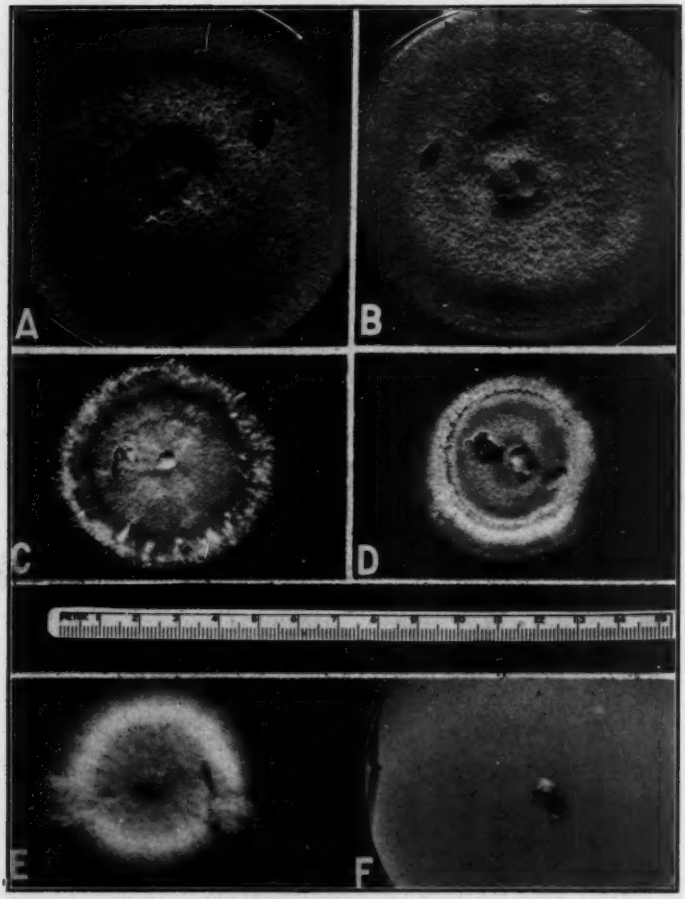

FIG. 2. *Polyporus guttulatus* Pk. and *Ptychogaster rubescens* Boud. grown at room temperature of about 26° C. *A* and *B*. *P. rubescens* (Idaho and Minnesota culture), after three weeks on two per cent malt agar. *C* and *D*. *P. guttulatus* (*71286-R* and *71799-S*), grown under same conditions as *A* and *B*. *E* and *F*. *P. rubescens* (Holland culture), after fourteen days on two per cent malt agar containing 0.5 per cent gallic and tannic acid respectively.

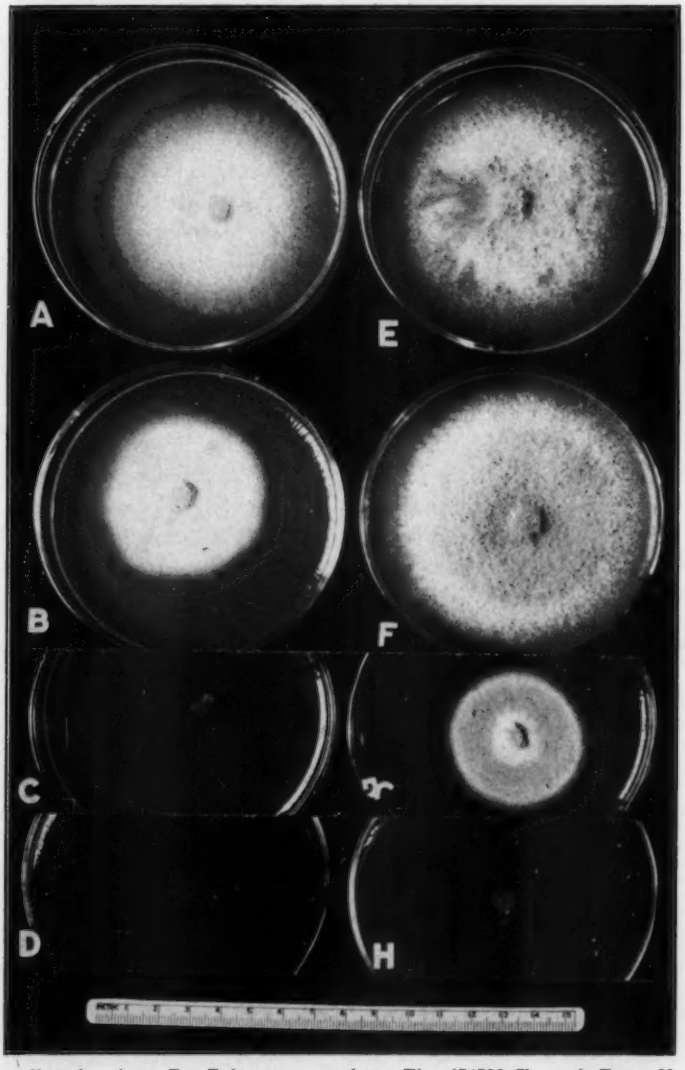

FIG. 3. *A* to *D*. *Polyporus guttulatus* Pk. (*71799-S*), and *E* to *H*, *Ptychogaster rubescens* Boud. (Idaho culture). *A* and *E*. Cultures grown on two per cent malt agar, in the dark, at a constant temperature of 22° C.; *B* and *F*, at 26° C.; *C* and *G*, at 32° C.; and *D* and *H*, at 35° C.

brown, elongate, rounded at one end and often truncate at the other, and measure 6–9 × 3–4 μ, whereas those of *P. guttulatus* are similar except that they are usually lighter brown and 5–7 × 2.5–4 μ.

Both fungi when grown on sterilized blocks of moist coniferous wood cause a brown cubical rot within a few months. Cultures of *Polyporus guttulatus* often form abortive sporophores on such wood blocks, and sometimes on malt agar in test tubes. These sporophores are hemispherical, 3–6 mm. in diameter, pale tan with a greenish tinge, and consist of a mass of daedaloid pores in which typical basidia and basidiospores are borne.

Cultures of *Ptychogaster rubescens,* obtained from the conidial fruit body on cypress wood of a greenhouse bench in St. Paul, were inoculated into bolts of cypress (*Taxodium distichum* (L.) Richard) about 8 inches in diameter and 30 inches long in October 1942. In 1944 several fruit bodies appeared—first the hemispherical masses of brown conidia, then white shelves of polypores; the latter were tentatively identified as *Polyporus guttulatus* by Davidson and Overholts. Cultures made from these shelflike fruit bodies were identical with the original cultures of *Ptychogaster rubescens.* This evidence, supported by that obtained from the comparison of cultures, suggests that *Ptychogaster rubescens* may be no more than a variety within the limits of variation of *P. guttulatus.*

SUMMARY AND CONCLUSIONS

Fruiting bodies of *Polyporus guttulatus* were found associated with a brown butt rot of living black spruce (*Picea mariana*) as well as with a brown butt rot of dead black spruce and other coniferous species or on stumps of conifers in Minnesota. It is believed that in most cases the fungus enters through roots of living trees and causes heart rot in the lower part of trunks of such trees while they are still alive. The sporophores usually develop after the trees die or are felled.

Cultures from the sporophores of *Polyporus guttulatus* from the decayed black spruce resembled cultures of *Ptychogaster rubescens* from a greenhouse bench, a cedar pole, and one from an unknown source in Holland. Cultures of *Ptychogaster rubescens* grew faster and had a slightly different temperature range than those of *P. guttulatus.*

A cypress log inoculated with a pure culture of *Ptychogaster rubescens* developed a *Polyporus* sporophore tentatively identified as *Polyporus guttulatus*. At present the writers suggest that *P. rubescens* may be only a variety of *P. guttulatus*.

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MYCOLOGICAL NOTES. VIII

C. L. Shear

(with 1 figure)

32. Sphaeria albopruinosa Schw.

No specimen of this species is to be found in the original packet so labelled in Schweinitz' herbarium. The label says "Hope," which was apparently the New Jersey locality cited by Schweinitz (Syn. Fung. Am. Bor. 195, no. 1238. 1832). Hope is a small town northeast of Phillipsburg.

There is an autographed Schweinitz' specimen at the Philadelphia Academy of Natural Sciences in the Collins' series of Sphaerias collected by Schweinitz. The host is evidently *Salix* and not *Fagus* as given in the original description. A slide from this specimen shows allantoid, yellowish spores, $12 \times 4\ \mu$. Schweinitz' specimen in his mounted collection at the Academy appears the same under a lens and is on the same host, but is young or poorly developed and spores could not be found. M. C. Cooke, who transferred the species to *Diatrype* (Grev. **13**: 37. 1884) notes, "Sporidia allantoid, pale fuscous, .02–.022 × .004 mm." As no specimen is cited, these measurements may have been supplied by W. C. Stevenson who furnished information on Schweinitz' material to Cooke, as indicated in the introduction to the latter's article (l. c.). There appears to be an error in the length of spores cited since others, the writer included, have found them to measure 12–16 × 2.5–4 μ as recorded by Ellis (No. Amer. Pyren. 570. 1892).

Eutypella shearíana Berl. (Icones Fung. **3**: 68, pl. 83, fig. 1. 1905) is simply a form of *Diatrype albopruinosa* with small stromata as originally determined and labelled by the writer under his no. *576*. A portion of this collection was sent to Berlese, who described it as a new species and gave the spores as 14–16 × 4–5 μ. By a typographical error the specific name was printed *"sehariana."* Our portion of this collection agrees with Schweinitz' type in every particular, except that some of the stromata are smaller than

usual. Berlese did not see any of Schweinitz' specimens of *S. albopruinosa,* but refers it on the basis of descriptions to *Diatrype disciformis* var. *macrospora* Berl. It is not clear why he referred my specimen to *Eutypella* as it has a typical diatrypoid stroma. I was unable to locate Berlese's types in Italy. There are, however, all

FIG. 1. *Rhizomorpha corynephora. A,* Coll. N. Funck and L. G. Schlim, Voyage Linden, Venezuela, 1841, in the Brussels herbarium. *B,* coll. E. Ule, Amazonas, Brazil, 1900, in Sydow, Fungi Exotici Exsiccati, no. *550.*

sorts of intermediate conditions and forms between *Diatrype* and *Eutypella. E. shearíana* should be reduced to synonymy with *D. albopruinosa.*

Diatrype durieui Mont. on the basis of specimens so labelled in the Curtis herbarium was considered by Ellis and Everhart (No. Amer. Pyren. 570. 1892) as a further synonym of *D. albopruinosa.*

This species according to Berlese (l. c.) is a totally different fungus. The synonomy is as follows:

DIATRYPE ALBOPRUINOSA (Schw.) Cke. Grev. **13**: 37. 1884.
Sphaeria albopruinosa Schw. Syn. Fung. Am. Bor. 195, no. *1238*. 1832.
Eutypella shearíana Berl. Icon. Fung. **3**: 68. 1905.

33. ROSELLINIA CUTICULARIS (Schw.) Ell. & Ev.

This was described by Schweinitz (Syn. Fung. Am. Bor. 210, no. *1505*. 1832) as follows:

> 1505. 360. S. CUTICULARIS, L.v.S., passim in cortice denudato Bethl. affinis priori, sed tamen sequentibus notis distincta. S. simplex, subiculo insidens cuticulari splendente-candido vix manifestim floccoso, longitudinaliter effuso angusto, non pulverulento. Peritheciis subsparsis hemisphaericis atro-nitidis, papillatis. Magnitudine prioris.

A very small specimen with this name is found in Schweinitz' mounted collection at the Philadelphia Academy. It shows a few superficial scattered to united perithecia on the surface of rotten wood and agrees with his description. This is the only specimen that has been located. It is not mentioned by Fries, nor is it listed by Curtis as in his herbarium. It is not checked in Berkeley's copy of Schweinitz' Synopsis Fungi Amer. Bor. as having been seen by him. There is no specimen in the Collins' set of Schweinitz' fungi, nor in the Michener herbarium. No one seems to have seen the spores of this heretofore. Ellis (No. Amer. Pyren. 175. 1892) says "We find no measurements of the sporidia of this species." A slide from the Schweinitz' specimen at the Philadelphia Academy cited above shows about a half dozen free spores 12–13 × 6–7 μ having the same appearance as those of *Rosellinia subiculata* (Schw.) Sacc., originally described by Schweinitz (Synopsis fungorum Carolinianae superioris, 44. 1822) as *Sphaeria subiculata*. It is evident that *S. cuticularis* is a mere form or condition of *R. subiculata* in which the subiculum has all disappeared except a thin whitish crust or "cuticle." I have collected excellent specimens showing this condition of the subiculum, but all intermediate forms are found.

Berkeley (Grev. **4**: 52. 1875) cites the species as *Hypoxylon subiculosum*. Cooke in his Synopsis Pyrenomycetum (Grev. **15**:

124. 1887) calls it *Byssosphaeria cuticularis* and lists it under "Species dubiae" without spore measurements. Ellis and Everhart (l. c.) refer it to *Rosellinia cuticularis* (Schw.). Specimens are found in the following Exsiccati: Ravenel, Fungi Amer. Exsic., nos. *650, 743,* as *Hypoxylon subiculosum;* Ravenel, Fungi Car., no. *72,* as *Sphaeria subiculata;* Ellis, North Amer. Fungi, no. *182,* as *Sphaeria subiculata.*

34. SPHAERIA ATROFUSCA Schw.

Schweinitz (Syn. Fung. Am. Bor. 206, No. 1429. 1832. Nec Fr. nec Berk. & Curt.) in his discussion of this species mentions only one gathering of it. This was on *Staphylea trifolia* from Bethlehem, Pa. Fortunately parts of this specimen, bearing good perithecia agreeing with the description, are available in Schweinitz' original packet, as well as in his mounted collection and the Collins' herbarium, all at the Philadelphia Academy. There are also portions of the type collection in the herbaria of Berkeley, Curtis, Fries, and Michener.

In 1885 Ellis examined Schweinitz' type at Philadelphia and reported (Jour. Myc. **1**: 140. 1885) that he found it to be a *Nectria,* with spores 10–12 × 4.5 μ. Cooke (Grev. **20**: 85. 1892) examined that part of the type deposited in Berkeley's herbarium at Kew and found it to be also a *Nectria* with spores 10–12 × 4 μ. Starbäck (Bih. K. Svenska Vet.-Akad. Handl. Bd. **19**, Afd. III, No. 2: 94, pl. 4, fig. 73. 1894) records the results of his study of a specimen of this species which Schweinitz sent to Fries. He found mostly a pycnidial fungus which he referred to *Pseudodiplodia* as *P. atrofusca* (Schw.) Starb. In his copy of Schweinitz' *Synopsis Fungorum in America Boreali* at the Farlow Herbarium, Curtis has written opposite Schweinitz' no. *1429* "= Nectria."

We have examined that part of the type which is still in Schweinitz' original packet and find only the *Nectria* reported by Ellis, Cooke, and Curtis. The same is true of other portions of the type collection found in the Collins' and Michener herbaria. All have ascospores 13–15 × 4–5 μ, somewhat larger than the measurements given by Ellis and Cooke.

Seymour (Host Index of the Fungi of North America 473.

1929) records Schweinitz' species on *Staphylea trifolia* with the following synonymy:

> "*Creonectria atrofusca* (Schw.) Seaver
> *Melogramma atrofuscum* (Schw.) Cke.
> *Nectria atrofusca* (Schw.) Ell. & Ev.
> *Pseudodiplodia atrofusca* (Schw.) Starb.
> *Sphaeria atrofusca* Schw.
> *Valsaria atrofusca* (Schw.) Sacc."

Creonectria atrofusca (Schw.) Seaver. This combination was made by Seaver (Mycologia **1**: 186. 1909), who based it on a specimen collected by Everhart at West Chester, Pennsylvania, and issued as No. *1547* in Ellis and Everhart's North American Fungi. This is the true *Sphaeria atrofusca* of Schweinitz. The writer does not regard *Creonectria* as a valid genus.

Melogramma atrofuscum (Schw.) Cke. This name is apparently based on Cooke's reference (Grev. **15**: 80. 1887) to "*Melogramma* (*Valsaria*) *atrofusca* Schw. Sacc. Syll. no. 4227, Herb. Berk. no. 9925. Sporidia uniseptata 10–12 μ long." Sacc. no. *4227* [Syll. Fung. **2**: 391. 1893] cited by Cooke is a literal copy of Schweinitz' original description of *Sphaeria atrofusca* from his Syn. Am. Bor. Specimen no. *9925* from the Berkeley herbarium from which Cooke's description of the spores was made has not been seen, but it must have had colored spores to be referred to *Melogramma* or *Valsaria* and hence could not be the same fungus as *Nectria atrofusca* (Schw.) Ell. & Ev. This is not *Melogramma atrofusca* (Berk. & Curt.) Cke. in Grev. **13**: 108. 1885 which equals *Anthostoma atrofuscum* Berl. & Vogl. This latter binomial is discussed under *Hypoxylon* in an article in Lloydia **8**: 258. 1945.

Nectria atrofusca (Schw.) Ell. & Ev. This combination by Ellis and Everhart (Jour. Myc. **1**: 140. 1885) was based on the study of a specimen from Schweinitz' herbarium which is part of the true type.

Pseudodiplodia atrofusca (Schw.) Starb. Starbäck (l. c.) based this binomial on his examination of a specimen of Schweinitz' found in Fries' herbarium. He says that he found mostly *Pseudodiplodia* on this specimen, but also a little of the *Nectria* described by Ellis and Everhart. He suggests that the *Pseudo-*

diplodia may be the pycnidial form of the *Nectria*. Until this is demonstrated by pure culture studies, the pycnidial fungus Starbäck saw cannot be considered as belonging to Schweinitz' species.

Valsaria atrofusca (Schw.) Sacc. This name, cited by Seymour (l. c.), is based on Saccardo's use of the name (Syll. Fung. **9**: 759. 1891) which he cites as "*Valsaria atro-fusca* (Schw.) Cke. in Grev. *Sphaeria* Schw., Herb. Berk. n. 9925." The Grevillea reference (Grev. **15**: 80. 1889) referred to here by Saccardo is that in which Cooke uses the combination *Melogramma* (*Valsaria*) *atrofusca* as discussed above under *Melogramma*.

The following specimens of *Nectria atrofusca* (Schw.) E. & E. are present in the Mycological Collections of the Bureau of Plant Industry: Ellis and Everhart, No. Amer. Fungi, no. *1547*, coll. B. M. Everhart, West Chester, Pa., 1885; C. L. Shear, Plummer's Island, Maryland, 1903, C. L. Shear, no. *6054*, Herndon, Va., 1926; Mason and Diehl, Fairfax Co., Va., 1931; Schweinitz, Bethlehem, Pa., in herb. Michener (as *Sphaeria*). All these specimens are on *Staphylea trifolia*.

35. SPHAERIA ATROFUSCA Fr.

Fries (Summa Veg. Scand. 388. 1849) listed this as a new species (item no. 7) under his section Byssisedae of *Sphaeria* but without description, so that it is a *nomen nudum*. Starbäck (Bih. K. Svenska Vet.-Akad. Handl. Bd. 19, Afd. III, no. 2: 38. 1894) after studying Fries' type, reduced the name to synonymy under *Lasiosphaeria racodium* (Pers.) Starb.

36. RHIZOMORPHA CORYNEPHORA Kunze

This name first appeared on the printed labels of specimens collected by Chr. Weigelt in Surinam in 1827 and issued in the first century of his Exsiccati in 1828. The fungi in this set were named by Kunze. The only specimen of the original collection we have seen is that part of the one found in Schweinitz' herbarium at the Philadelphia Academy which is now in the Michener herbarium in the Mycological Collections of the Bureau of Plant Industry. It is labelled as follows: "*Rhizomorpha corynephora* Kze. *Isaria arbuscula* Schw. mss. ad viva planta Surinam." Some of the printed

labels of Weigelt's exsiccati, as determined by Kunze, are accompanied by diagnoses and some are not. We have not seen the original label of this species, but have found no evidence that it bore a description. Even if it did, it would not be valid under the rules of botanical nomenclature, as but few sets of this were distributed.

The next mention of the fungus is by Montagne (Ann. Sci. Nat. Bot. (sér. II) **14**: 331. 1840), who listed it as follows, "*Rhizomorpha corynecarpos* Kze. in Weig. Surin. exsic.—Lepr. Coll. 688." Whether Montagne is responsible for the change of specific name from *corynephora* to *corynecarpos,* we do not know. This is the first use of this form of the name we have found.

In 1841 there was a Belgian expedition to Venezuela headed by Jean Jules Linden. Botanical specimens were collected by L. G. Schlim and N. Funck, the latter was the artist of the expedition. We have not seen the report of this expedition, but a brief account of it is given on page 9 of H. Pittier's article, *La evolucion de las ciencias naturales y las exploraciones botanicas en Venezuela,* published in Caracas in 1920. We found in the Brussels herbarium a specimen of this fungus labelled "*Rhizomorpha corynephora* Kz. no. 394 Voy. Funck & Schlim, Caracas, Venezuela. 1841." The last part of the specific name had been crossed out and *carpos* written above. This is the ending used by Montagne in 1840 as cited above. A portion of this specimen is illustrated in figure 1.

Berkeley and Curtis on page 293 of their paper on *The Exotic Fungi from the Schweinitzian Herbarium, principally from Surinam* (Jour. Acad. Nat. Sci. Phila. **2** (n. ser.): 277–294. 1853) list the species as follows: "*Rhizomorpha coronephora* Kze.= *Isaria arbuscula* Schw. mss. A curious mycelium apparently common in Surinam." This statement is based on a portion of the original Weigelt collection brought to Schweinitz by Dr. Hering, the companion of Weigelt. Part of the Schweinitz specimen is in the Michener herbarium as already indicated. Berkeley and Curtis here give another spelling of the specific name with a different meaning, but probably only a typographical error.

Berkeley in his *Decades of Fungi* (Hooker's Jour. Bot. **8**: 277. 1856) records the fungus as follows:

"*Rhizomorpha corynephora* Kze. Weig. Exs. Spruce n. 149. Hab. Panure. It is scarcely necessary to say that this is no autonomous fungus."

Streinz (Nomenclator fungorum, 501. 1862) lists *R. corynecarpos* Kze. as a synonym of *Cordierites guianensis* Mont. This is clearly an error as Montagne (l. c.) merely lists the *Rhizomorpha* as a separate item following *Cordierites,* with no evidence that he regarded them as synonymous. On the same page under no. *7984* Streinz lists *R. corynephora* Kze. as being found in Hostman's Cryptogamic exsiccati, no. *179,* from Surinam. We have seen no specimens from this collection.

The next mention of the fungus is by Saccardo (Syll. Fung. **14**: 1184. 1899) as follows:

"26. *Rhizomorpha corynephora* Kunze in Weig. Exs.; Berk. in Hook. Jour. (1856) 277 (absque diagnosi).

"Hab. ad truncos (?) Rio Javary, Panure Brasiliae."

Hennings (Hedwigia **43**: 398. 1904) in his account of the Amazonian fungi collected by E. Ule lists and discusses this fungus as follows:

Rhizomorpha corynephora Kze. Weig. Exs.
Rio Jurua, Jurua-Miry und Marary: An Baumzweigen. September 1900, Mai 1901. No. 2726, 3095.
Die wunderbaren, korallenähnlichen Bildungen, deren Zusammengehörigkeit bisher vollig zweifelhaft ist, hangen in verzweigten bis ½ m. langen Buscheln von den Baumzweigen frei herunter und werden wie auch andere Rhizomorphenformen von den Vögeln zum Nesterbau benutzt. Ein derartiges Nest wurde von Herrn Ule an Ort und Stelle gesammelt. Die Rhizomorphen sind, aus dicht verflochtenen, gelblichen verholzten Hyphen bestehend, aussen mahlig-filzig, reich verzweigt, die Zweige meist 1–2 mm. dick, mit dichtstehenden, oft abwechselnd langen, meist keulenförmigen stumpfen, mitunter an der Spitze verbreiterten oder geteilten 2–10 mm. langen, 1–3 mm. breiten kreidig-weissen, fast mehlig-bestäubten Seitenästchen. Der Pilz ist den Baumen äusserst schädlich, er tötet die Kronen derselben oft in weitem Umkreise völlig ab.

This is the first printed description of the fungus we have found and is therefore the date of its first valid publication. The Ule collections of 1900 and 1901 cited by Hennings, were issued in later years in exsiccati, the first by H. Sydow about 1923 (Fungi exotici exsiccati, no. *550*) as "*R. corynecarpos* Kze. in Weigelt exsicc. (sine no.)," and the second by Ule himself in 1905 (Mycotheca brasiliensis, no. *100*) as *R. corynephora* Kze. On the label of this specimen in the Mycological Collections of the Bureau of Plant In-

dustry the name had been changed in ink before being issued, presumably by Ule, to *corynecarpos*.

Hennings again (Hedwigia **48**: 117. 1908) lists the fungus in his third paper on *Fungi Paraenses* as "*Rhizomorpha corynecarpos* Kze. in Weigelt Exs. 1827. *Rh. coryneclados* Kze.—*Rh. corynephorus* in Sacc. Syl. XIV, p. 1184." The reference in this case is based on a specimen collected by J. Huber, which we have not seen.

According to our studies as recorded above the fungus had been named by the several workers who have considered it as follows:

1828. *Rhizomorpha corynephora* Kunze in Weig. exsic.
1840. *Rhizomorpha corynecarpos* Montagne Ann. Sci. Nat. Bot. (ser. II) **14**: 331.
1841. *Rhizomorpha corynecarpos* Schlim and Funck in herb.
1853. *Rhizomorpha coronephora* Berkeley and Curtis Jour. Acad. Nat. Sci. Phil. **2**: 293.
1856. *Rhizomorpha corynephora* Berkeley Hooker's Jour. Bot. **8**: 227.
1862. *Rhizomorpha corynecarpos* Streinz, p. 501.
1899. *Rhizomorpha corynephora* Saccardo Syll. Fung. **14**: 1184.
1904. *Rhizomorpha corynephora* Hennings Hedwigia **43**: 398.
1908. *Rhizomorpha corynecarpos* Hennings Hedwigia **48**: 117.

The valid name as already indicated is *Rhizomorpha corynephora* Kunze apud P. Hennings. 1904. The original form of the specific name as used by Kunze was *corynephora*, signifying the club-bearing rhizomorph. The name *corynecarpos* meaning club-fruited was attributed to Kunze by Montagne (l. c.), but we find no evidence that the former ever used it. Perhaps Montagne considered it more appropriate than Kunze's original. The form *coryneclados* used by Hennings has not been found elsewhere. It may be noted that the correct form of this specific epithet derived from the Greek should be *corynophora*.

The plant is of such a striking and unusual character that it is easily recognized. Figure 1 illustrates specimens from Venezuela and Brazil which agree with type material and show the variation in form and branching characteristic of the fungus. The large masses of yellow-white to gray rhizomorphs up to half a meter in length hanging from the branches of trees must make the fungus a conspicuous and attractive object. As a parasite it may have economic significance. It has been reported on guava and may well occur on other cultivated plants. No fructifications have been found by any of the collectors. The use of the specific name *corynecarpos*

by Montagne suggests that he may have regarded the club-shaped lateral branches as fructifications (FIG. 1).

In addition to specimens already discussed the following are to be found in the Mycological Collections of the Bureau of Plant Industry: Panyos, Guatemala, coll. O. F. Cook; Cabo Gracias a Dios, Nicaragua, F. A. Schramm, March 1923; Chagras, Panama Canal Zone, collector unknown, Sept. 1915; Panama Canal Zone, O. A. Barrett, 1915 on *Psidium guava;* Rio Madera, Brazil, J. R. Weir, Sept. 1923; Rio Madre de Dios, Bolivia, J. R. Weir, Oct. 1923.

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THE IDENTITY OF PORIA MONTICOLA

L. O. Overholts [1]

(with 1 figure)

In 1920 Dr. Murrill (Mycologia 12: 90) described *Poria monticola* based on a collection made by J. R. Weir on *Pinus monticola* at Priest River, Idaho. Some 6 other collections were cited as representing the same species. Packets of all of these are preserved at New York and another lot at Washington. Of course, only the first mentioned is pertinent here. Also, there is a fragment from the packet in the Farlow Herbarium at Cambridge, marked, as other such fragments are marked at Cambridge, simply with the above data, without any reference to the origin of the specimen. I am indebted to Dr. J. L. Lôwe of Syracuse University for calling my attention to this specimen.

Lloyd apparently was the first to examine the portion of the type collection at New York. He reported that it was only *Trametes serialis*. I have no record of when I first examined this collection, but it was not long after Lloyd reported on it, and it may have preceded his report. I, likewise, set it down as belonging to the *T. serialis* complex, because of the similarity of the spores I found, and other characters, that were obviously the same. The spores of *T. serialis* are rather characteristic, being elongated, pointed at one or both ends, and measuring 7–8 × 1.5–2.5 μ. I may add at this point that *T. heteromorpha* usually differs from this species not only in the size of the pores but also in spore size, the spores of that species typically measuring 9–14 × 4–6 μ. Likewise *T. serialis* is also frequently confused with *T. variiformis* Peck but again can with most certainty be separated on spore size, these being 5–8 × 2–3 μ. Of course, all of these measurements can be arranged in a progressive series and the conclusion drawn that they are all variants of a common polymorphic species. They all inhabit

[1] Dr. Overholts died Sunday, November 10, 1946. This paper is therefore published with editorial corrections only. A. H. Smith.

FIG. 1. Photo of entire collection (type) of *Poria monticola* Murr. as preserved at New York. The specimen at the left is *T. serialis*, that on the right *P. monticola*. × 1¼.

the same woods, produce the same type of rot, and are equally ubiquitous and widespread. Forest pathologists are interested in these species from the decay standpoint, and the group has been much in the minds of investigators recently, and I take this opportunity to present my views on their status. Even *Trametes sepium* may well enter into the discussion since occasionally it is found on conifers, produces the same type of decay, and when in resupinate condition (as it usually is on these substrata) can be distinguished only by reference to its spores. The spores of *T. sepium* are of about the length of those of *T. heteromorpha* but are narrower, measuring 8–11 × 3.5–4.5 μ.

In the course of some cooperative investigations with me in the genus *Poria*, Dr. Lowe spent considerable time in my laboratory recently and then went to the Farlow Herbarium to continue the work. Among the specimens studied at Cambridge was the

fragment of the type collection of *Poria monticola*. After going over its characters as represented by this fragment he queried me as to how it differed from *P. microspora*—a name proposed by me for a fungus which has been confused with *T. serialis* but which differs in having entirely different spores as well as in other characters as set forth in the original description in a paper by Dr. Nobles where the species was originally published (Can. Jour. Res. C **21**: 220. 1943).

Since my own conception of the autonomy of *P. monticola* was involved, I at once sent for the type collection of Murrill's species as preserved at New York. Briefly, what I found was as follows.

This collection (FIG. 1) consists at the present time of two specimens. The larger specimen is *T. serialis;* spores and hyphae are in complete agreement. The smaller and wholly insignificant and quite inadequate specimen has all the characters of *Poria microspora*. I think a glance at the photo of the two specimens is enough to excuse both Lloyd and myself for the error into which we were led in referring the species to *T. serialis*. There is in the packet a spore print on a piece of black paper and when these spores are examined they are found to be typical of those of *P. microspora,* and spore data for the original description of *P. monticola* were undoubtedly taken from that source. Relying on my own ability to gather spore data from the specimen that was sectioned, I did not examine spores from the spore print of the real *P. monticola* specimen, else I would probably have noted the discrepancy.

The other collections, all by Dr. Weir, with the types of *P. monticola* at New York are a different matter. In the absence of spores it is sometimes not easy to decide the identity of specimens belonging to this group. Such is the condition of the two other packets mounted on the same sheet with the type packet at New York.

At any rate, Murrill's name must replace *P. microspora* recently described by me, and I hereby offer my deepest apologies to that individual for my (unpremeditated) attempts to suppress his species and to reduce it to a condition of "innocuous desuetude."

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CLAUDOPUS VARIABILIS ON GRAY DUCK FROM SHADED AERIAL EXPOSURE IN PANAMA

ROBERT K. ZUCK

(WITH 1 FIGURE)

It has been pointed out in a previous paper (3) that species of angiocarpous fungi with dark hyphae are associated with the decomposition of cellulose in gray cotton duck during unshaded aerial exposure without ground contact. Consequently, the presence of sporophores of *Claudopus variabilis* (Fr.) Gillet on gray duck exposed in the Panama jungle is of considerable interest. The fabric samples were exposed on horizontal racks for three months, August 25, 1945–November 25, 1945, when the sporophores were discovered on the under surfaces. The photograph (FIG. 1) shows that the mycelium associated with the sporophores is white in color and has invaded and decolorized the fungal colonies with dark hyphae.

This appears to be the first report of basidiomycetous sporophores found fruiting on gray duck during aerial exposure without ground contact. The low light intensity and exposure during the rainy season are considered to be of primary importance in the growth and fruiting of this fungus on the cloth.

Thom and Phillips (2) report high percentages of lignin in the several species of fungi with dark hyphae tested by them. In some instances, as much as twenty-nine per cent of the dry weight of the fungus was lignin. This work is further substantiated by Pinck and Allison (1) working with additional species of fungi. It is suggested that *C. variabilis*, which ordinarily grows on wood, may utilize the lignin and other constituents of the fungi with dark hyphae present on the cloth, as well as the cellulose of the fibers. The white areas produced by *C. variabilis* on the gray duck are much weaker than the areas invaded by the dark colored fungi. The entire exposed sample is very much weakened in comparison with the original.

The collection of the material was made while the author was on temporary duty with the Quartermaster Corps of the U. S. Army

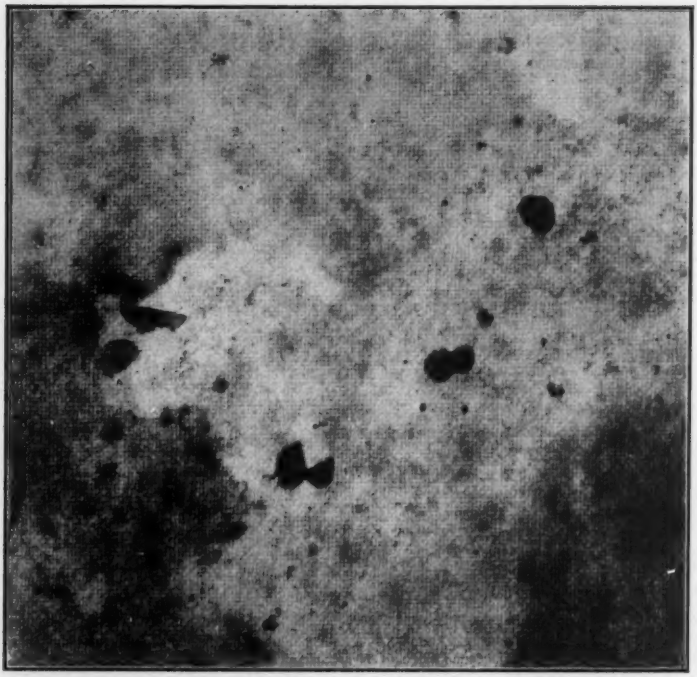

FIG. 1. Sporophores of *Claudopus variabilis* on gray duck. × 1. Photograph by Mr. M. L. Jaeger.

in Panama. *C. variabilis* was determined in conjunction with Dr. Wm. W. Diehl of the Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A. A specimen of the fabric with sporophores has been deposited with the mycological collections of the Bureau.

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KERNIA, A NEW GENUS OF THE UREDINALES

M. J. THIRUMALACHAR

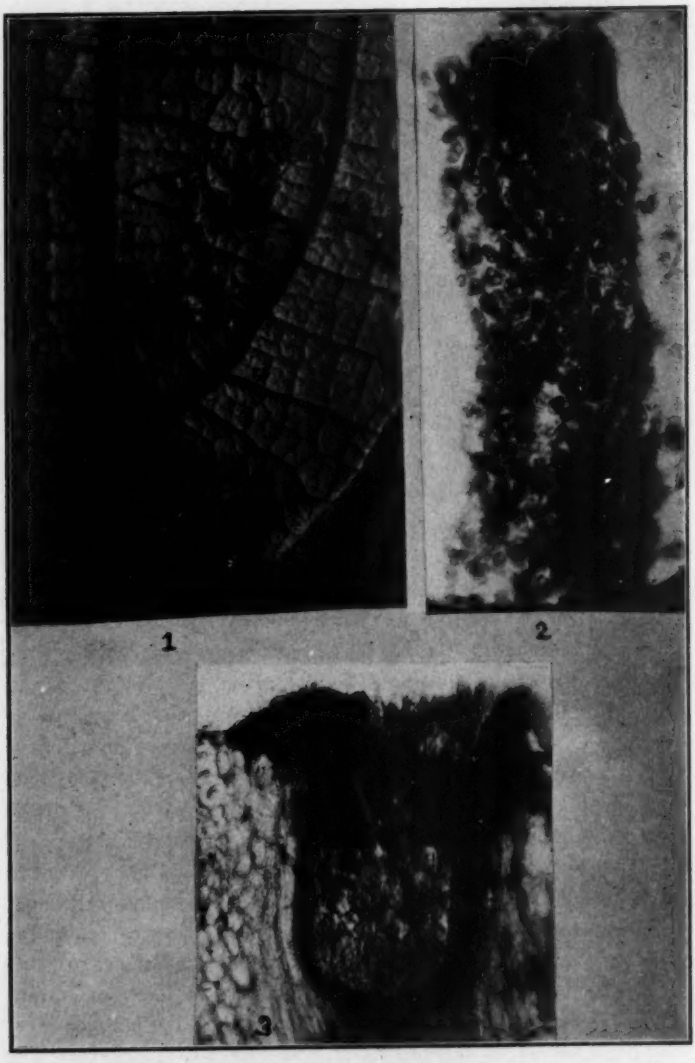
(WITH 9 FIGURES)

In a recent collection of rusts made by the writer near Mercara, Coorg, South India, a leaf rust on a species of *Litsea* (Lauraceae) was observed which on examination proved to be of great interest. The rust is folicolous and hypophyllous developing small hypertrophied cushions from which numerous *Cronartium*-like spore columns emerge (FIG. 1). When these spore columns are grouped in close proximity they present the false appearance of tomentose outgrowths from the leaf surface.

The material for microscopic study was fixed in formalin-acetic alcohol and microtome sections of 10 to 12 μ thickness were cut and stained with Newton's iodine gentian violet.

The infection spot is visible on the upper surface as spherical to irregular discoloration spots. The rust is strictly hypophyllous but on rare occasions infections were observed on tender shoots and petioles. The infection spot on the lower surface first appears as a tiny greenish-yellow pustule and gradually enlarges into a discoid hypertrophied cushion of five to eight millimeters in diameter. The margin of the infection spot is sharply delimited from the rest of the leaf surface.

The rust is a microcyclic form with telia only. Pycnia have not been noticed in any of the collections and it seems probable that they are absent in the life-cycle. The sori are deep seated within the host tissue beginning their development a short distance beneath the palisade layer and growing out towards the lower epidermis. The initials of the telium are organized beneath the palisade layer by the grouping of coarse hyphae. Mature sori are cupulate like an aecial cup and lined with a fine hyphal layer (FIGS. 3, 4). Peridial cells or paraphyses have never been noticed. The host cells



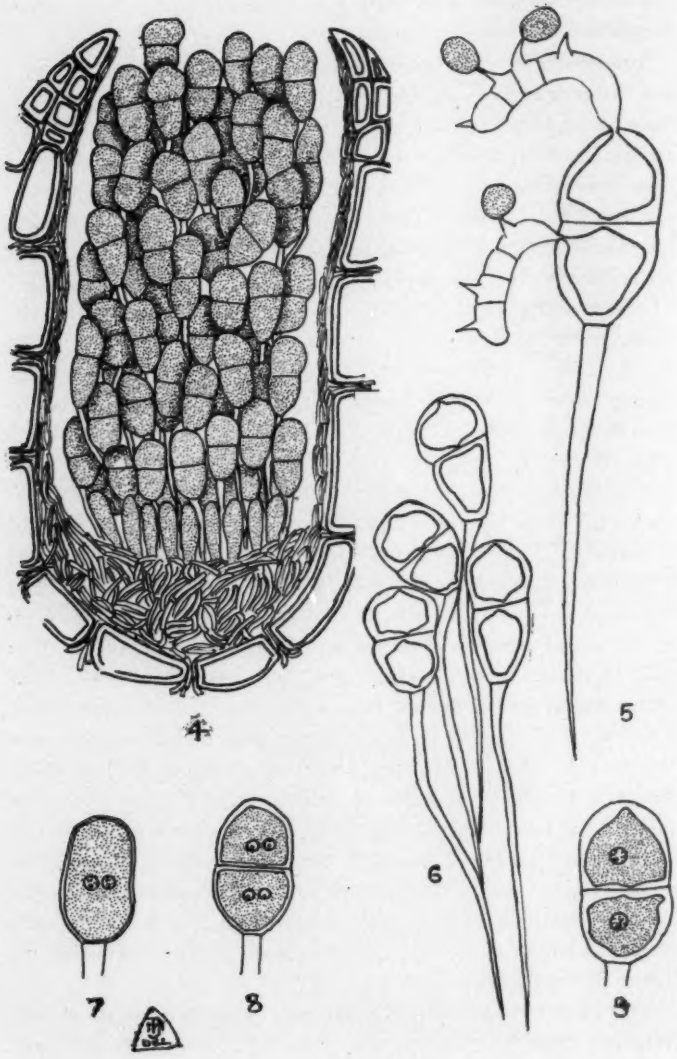
FIGS. 1–3. *Kernia Lauricola.*

bordering the mouth of the sorus form a rim of elevated tissue which possibly afford additional support for the spore columns.

Teliospores develop continuously from the base of the sori in a manner characteristic of the tribe *Pucciniosirae* of Dietel (1928). As each spore is formed from the base of the sorus it becomes detached and is pushed upwards by the younger spores developing around and below it. The mature spores are two-celled, pedicellate and *Puccinia*-like. The spores are definitely not catenate but the younger spores are formed between the older ones (FIG. 6). As spores are produced in rapid succession they get closely adpressed to one another and are pushed out of the sorus in long brownish-black spore columns giving the characteristic appearance of the spore columns of *Cronartium, Crossopsora, Masseeella* and others. The spore columns are cylindrical and semi-permanent to the extent that the spores in the columns could be separated only with pressure.

The developmental stages of the teliospore are as follows: a binucleate hyaline teliospore initial borne on a basal cell is first differentiated. Following a nuclear division, the teliospore initial gives rise to a uniseptate *Puccinia*-like spore. As the spore matures the original basal cell elongates into a long pedicel measuring up to 137 μ and becomes detached from the basal hymenium. The wall of the spore is thickened and turns yellowish-brown. The two nuclei in each cell of the spore fuse to form a syncaryon (FIGS. 7 to 9). The epispore is smooth and reveals a distinct germ pore in each cell. The pedicels are up to 137 μ long, and 4 μ broad at the point of attachment to the spore but gradually taper into a fine point at the base. The pedicels of the upper tiers of spores inarch over the teliospores at the base and appear closely adpressed to them. It is probable that this provides additional firmness to the spore column. The spore columns are mostly ten to fifteen millimeters in length and resemble in the mode of spore formation the genus *Skierka* Racib.

The teliospores germinate at maturity without a period of rest. When an intact spore column and sorus was observed, the germinating spores were noticed just above the mouth of the sorus. The promycelium emerges as a small papilla and gradually elongates, becoming cylindric and recurved. Later on it becomes four-



FIGS. 4-9. *Kernia Lauricola.*

celled and develops globular sporidia at the tips of the sterigmata (FIG. 5). Cytological studies reveal that the sporidia are all uninucleate.

The occurrence of the rust on the leaves of *Litsea* producing hypertrophied cushions and developing two-celled *Puccinia*-like spores immediately brings to mind the characters of the genus *Xenostele* described by Sydow (**1920**) on the two Lauraceous hosts *Litsea* and *Actinodaphne*. The sori in this genus are cupulate and lined with a well developed peridial layer which led previous workers to mistake the two rusts for species of *Aecidium*. Though the rust under investigation occurs on Lauraceae, the complete lack of any peridium clearly distinguishes it from *Xenostele*. Further, the long spore columns are not known to occur in the two species of *Xenostele* so far recorded.

Long *Cronartium*-like spore columns composed of two-celled teliospores are known to occur in the genera *Gambleola* Massee, *Didymopsora* Diet. and *Pucciniosira* Lagerh. *Gambleola* is a monotypic genus on the leaves of *Berberis nepalensis* developing long hair-like teliospore columns. The spores are produced in catenations, the sterile intercalary cells simulating pedicels for the teliospores. The presence of a single layer of peridium surrounding the telial columns was pointed out by Jackson (**1931**) and confirmed again by the writer (Thirumalachar, **1946**). The lack of any such peridial layers or catenate teliospores clearly distinguishes the rust under study from *Gambleola*.

The genus *Didymopsora* founded by Dietel (**1899**) is characterized by the presence of short telial columns of few millimeters. The spores are produced in chains and are sessile. In many cases the two cells of the spores show tendencies to get separated. Likewise, the genus *Pucciniosira* possesses two-celled teliospores which are produced in catenations. There is a well developed peridial layer lining the sorus, and in many species the occurrence of intercalary cells separating spores are present. The rust under investigation differs entirely from the two abovementioned genera in the type of spore column produced and in having pedicellate teliospores. The genus *Gymnosporangium* Hedwig. also possesses two-celled pedicellate teliospores emerging in variously shaped gelatinous spore horns. The jelly-like matrix in which the spores

appear to be embedded as well as other characters clearly distinguish the genus from the rust collected by the writer on *Litsea*.

In the shape of the spore columns, and probably in the mode of spore development, there appears to be a close resemblance between the rust under study and the genus *Chardoniella* described by Kern (**1939**) on a species of *Gynoxis* collected in Colombia. This rust produces telial columns, as in *Cronartium* or *Cionothrix*, with one-celled pedicellate teliospores developed within deeply seated non-peridiate sori. The spore columns are produced by the lateral adpression of the teliospores to one another. Kern does not definitely state whether the teliospores are catenate or not, though his figures might be taken as indicating that the younger spores are produced between the older ones. This feature is very evident in the genus *Skierka* investigated in detail recently by Mains (**1939**). Here the young teliospores are produced between the older ones and long semi-permanent teliospore columns are supported by the close grouping of the spores. The rust under study, although closely agreeing with *Chardoniella* in all essential features, differs from it in having two-celled instead of the one-celled teliospores. As it cannot be accommodated in any of the genera so far described, the writer proposes to present it as a new genus with the name *Kernia*, named in honor of Prof. F. D. Kern, of the Pennsylvania State College, distinguished American Uredinologist who has advanced our knowledge of the tropical rust fungi.

Kernia Thirumalachar gen. nov.

Pycnia, aecia atque uredia ignota. Telia subepidermalia, erumpentia, alte infixa in texturis plantae parasitatae, absque peridiis vel paraphysibus, producentia sporas 2-cellulatas, *Pucciniae* similes, pedicellatas successive, quae sporae non sunt catenatae, sed juniores teliosporae seniores inter evolvultur, lateraliter inter se adhaerentes, sporarum massa emergente *Cronartii* instar in longas, semi-permanentes sporarum columnas 10–15 mm. longas; sporae germinant in maturitatae absque ulla quiescentiae mora, promycelio externo atque 4-cellulato.

Species typica: *Kernia Lauricola* Thirumalachar.

Pycnia, aecia and uredia unknown. Telia subepidermal, erumpent, deep seated within the host tissue, without peridia or paraphyses, developing *Puccinia*-like, two-celled pedicellate spores in succession, which are not catenate but the younger teliospores developing between the older, adhering laterally to one another, spore

mass emerging out in long, semi-permanent *Cronartium*-like spore tendrils or columns, 10 to 15 mm. long; mature spores germinating without a rest period; promycelium external and four-celled.

TYPE SPECIES: *Kernia Lauricola* Thirumalachar.

Kernia Lauricola Thirumalachar sp. nov.

Pycnia aecia et uredia ignota. Telia hypophylla, simul aggregata in tumescentes, hypertrophisatas maculas gallis similes, 5–8 mm., subepidermalis, erumpentia, pluribus teliosporis *Pucciniae* similibus, 2-cellulatis, pedicellatis, simul aggregatis in semipermanentes sporarum columnas *Cronartio* similes; hae columnae sunt cylindricae, brunneo-nigrae, 10–15 mm. longae. Teliosorus alte infixus 160–200 μ latus, 280–340 μ profundus, absque peridiis vel paraphysibus, producens ad columnam adduntur. Teliosporae haud catenulatae, juniores sporae inter seniores positae, atque illis lateraliter adhaerentes; 2-cellulatae, pedicellatae, luteo-brunneae, tenuiter angulares ob lateralem compressionem, tenuissime vel nullo modo constrictae ad septa, magnitudinis 30–44 × 20–27.5 μ; episporium inequaliter crassum, circa 3–6 μ crassitudine, leve, unico germinationis poro in singulis cellulis; pediculo hyalino, 112–137 μ longo, 3–4 μ lato, ad apicem, atque gradatim ad basim acuescente. Teliosporae statim in maturitatae germinant, promycelio externo, 4-cellulato, recurvo; sporidiis globularibus, hyalinis, magnitudinis 8–10 μ diam.

Hab. in foliis *Litsea* spec. indet., Sontikoppa Road, Mercara, Coorg, South India, 26-3-1946, leg. M. J. Thirumalachar, *Thirumalachar 1300*. Typus positus in Herb. Crypt. Ind. Orientalis, New Delhi; in Imperial Mycological Institute, Kew, Anglia; atque in Arthur Herb. in Purdue Universitate, Lafayette, Indiana, U. S. A.

Pycnia, aecia and uredia unknown. Telia hypophyllous, grouped together on swollen gall-like hypertrophied spots 5–8 mm. in diam., subepidermal, erumpent, with numerous *Puccinia*-like two-celled pedicellate teliospores massed together in semipermanent *Cronartium*-like spore tendrils or columns which are cylindric, brownish-black, and measure 10 to 15 mm. in length.; teliosorus deep seated, 160–200 μ wide and 280–340 μ deep, without peridia or paraphyses, developing in succession from the base teliospores which become free and add to the column basipetally; teliospores not catenulate, younger spores wedged in between the older ones and adhering laterally to one another, two-celled, pedicellate, yellowish-brown, slightly angular due to lateral compression, very slightly or not constricted at the septa, measuring 30–44 × 20–27.5 μ, epispore unequally thickened, between 3–6 μ, smooth, with a single distinct germ pore in each cell; pedicel hyaline, 112–137 μ long, 3–4 μ broad at the apex and gradually tapering off into a fine point at the base; teliospores germinating immediately at maturity, promycelium external, four-celled and recurved, sporidia globular, hyaline, measuring 8–10 μ in diam.

Hab. on the leaves of *Litsea* sp., Sontikoppa Road, Mercara, Coorg, South India, 26-3-1946, leg. M. J. Thirumalachar, *Thirumalachar 1300*. Type deposited in the Herb. Crypt. Ind. Orientalis, New Delhi; Imperial Mycological Institute, Kew, England, and in the Arthur Herbarium, Purdue University, Lafayette, Indiana, U. S. A.

In conclusion the writer wishes to express his deep sense of gratitude to Rev. Dr. H. Santapau, Professor of Botany, St. Xavier's College, Bombay, for kindly rendering into Latin the diagnoses of the genus and species and to Dr. L. N. Rao, Professor of Botany, Central College, Bangalore, for kind encouragement. This portion of the work was carried out by the writer as a Research Fellow of the University of Mysore.

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EXPLANATION OF FIGURES

FIG. 1. Showing the spore columns on the lower surface of the leaf, nat. size. FIG. 2. Photomicrograph of the spore column slightly crushed × about 100. FIG. 3. Photomicrograph of the sorus × about 100.

FIG. 4. Section through the telium showing the development of the spores × 200. FIG. 5. Germinating teliospore with external 4-celled promycelium and sporidia × 800. FIG. 6. Showing the arrangement of the teliospores in the column × 400. FIGS. 7 to 9. Showing the stages in the development of the teliospores × 600.

TWO NEW SPECIES IN THE AGARICALES

ROLF SINGER

Rhodocybe Maire was originally proposed for species with pink, rough spores, and cystidia. The cystidia later (Singer, Lloydia **5**: 110. 1942 and Ann. Myc. **51**: 89. 1943) were found to be pseudocystidia, *i.e.*, cystidioid prolongations of the lactiferous system into the hymenium. In the same papers it was stated that *Rhodocybe* has clampless hyphae. Though the genus *Rhodopaxillus* Maire was generally believed to have clamp connections, it has been shown (Lloydia **5**: 110. 1942) that no clamps occur in *Rhodopaxillus nuciolens*. After a careful check upon all species and specimens available, it appears that all species of *Rhodopaxillus*, section Nitellini Sing. and section Decurrentes Konrad & Maublanc, lack clamp connections, and according to Kühner, they have binucleate spores. This and the incrusting pigment encountered in all these species as well as in *Rhodocybe caelata* show that they differ from species of the latter genus merely in lacking the pseudocystidia. On the other hand, the typical species of *Rhodopaxillus* have intracellular pigment, constant clamp connections, and according to Kühner (Bull. Soc. Linn. Lyon, Sept. et Oct. 1945, nos. **7** et **8**, p. 160–169), uninucleate spores. It appears, therefore, that the genus *Rhodocybe* should be emended. As emended it would consist of the sections Nitellinae (Sing.), Decurrentes (Konr. & Maubl.) and Genuinae Sing. (= *Rhodocybe* sensu originali). In South Florida a species of the Nitellinae has been found which differs from **Rhodocybe nitellina** (Fr.) Sing. comb. nov. [*Rhodopaxillus nitellinus* (Fr.) Sing.] as well as **Rhodocybe nuciolens** (Murr.) Sing. comb. nov. (*Melanoleuca nuciolens* Murr.) in having narrower and closer lamellae, clitocybeoid habit and less pigment, and it also differs from *R. nitellina* in having slightly smaller spores. It is possible that this new species which is designated *Rhodocybe alutacea* nob. is too close to one of Maire's African varieties of **Rhodocybe truncata** (Schaeff. ex Fr.) Sing. comb. nov.

(*Rhodopaxillus truncatus* (Schaeff. ex Fr.) Maire), viz. var. *mauretanica* or var. *subvermicularis*, but in this case I would not consider them conspecific with *R. truncata*.

Rhodocybe alutacea Sing. spec. nov.

Pileo gilvulo ("light pinkish cinnamon" Ridgwayi ad marginem extremum, ceterum inter "pinkish cinnamon" et "cinnamon buff") in statu humido, hygrophano, pallidiore vel albo in statu sicco (inter "pale pinkish buff" et "pinkish buff" vel pallidiore), levi vel substriatulo prope marginem, sericello vel subglabro, glabrescente, convexo, umbilicato, 25–35 mm. lato; cuticula consistente ex hyphis filamentosis, defibulatis, pigmento vix incrustatis, repentibus.—Lamellis subconcoloribus ("Light pinkish cinnamon"), angustissimis vel moderate angustis (1–3 mm. latis), confertis vel confertissimis, distincte decurrentibus sed subrotundatis ad stipitem; sporis sordide incarnato-hyalinis, ab apice visis rotundato-subangulatis *Clitopilorum* modo sed neque longitudinaliter venulosis nec subcanaliculatis sed verrucis irregularibus membrana incrassata formatis exasperatis, saepe collabentibus maturitate, ellipsoideis vel ellipsoideo-subangulatis sed a *Rhodophyllorum* typo longe recedentibus, 5.8–7.5 × 3.8–4.5 μ; basidiis 22–29 × 6–7 μ, tetrasporis; cystidiis nullis visis; tramate regulari, elementis filiformibus, tenuibus, parallelis vel subparallelis defibulatis composito. Stipite subconcolori ("light pinkish cinnamon" R.) vel albo, haud albo in exsiccatis, sed semper albo ad basin, subpubescente vel glabro, glabrescente, villoso ad basin, levi, solido, subaequali, 23–35 × 2.5–5.5 mm. Carne pilei stipitisque alba vel albida; odore farinaceo; sapore farinaceo mitique. Methylparamidophenol sine reactione. Ad humum sabulosum et ad folia delapsa; solitario in dumetis coniferis destitutis typi "low hammock" et "tropical hammock" in Augusto et Septembri mensibus. Florida meridionalis Dade Co. Simpson Park *F. 674* (FH); Matheson Hammock *F 674a* (FH), *F 908*, **type** (FH); Highlands Co., Highlands Hammock State Park, *F 451* (FH).

The Laccarias with large spores and the species with comparatively small spores have been studied satisfactorily in the past, but there is a group of probably two species with intermediate spores, *i.e.*, spores above 10 μ in diameter and with spines 1.5–2.5 μ long, but not reaching 15 μ and more closely resembling those of *L. echinospora* Speg. and *L. pumila* Fay. We are concerned here with two species, one studied in previous papers (Lloydia **5**: 102. 1942; Mycologia **35**: 151. 1943) as *L. striatula* Peck and *Clitocybe ohiensis* (Mont.) Sacc., the former being a synonym of the latter, and the other an undescribed form differing from **Laccaria ohiensis** (Mont.) Sing. comb. nov. (*Clitocybe ohiensis* Sacc.) in having four sterigmata on a basidium and being smaller in an average. Al-

though it is true that Lange was wrong in attributing specific value to the number of sterigmata in the agarics, as has been shown by numerous authors, among others A. H. Smith and R. Kühner in Mycenae, it does not appear to me to be desirable to insist that the number of sterigmata can never be of specific value. In the Laccarias, truly parallel forms (*i.e.*, forms with all characters in common excepting the number of sterigmata) have not been observed thus far, and although it is true that there are species with usually mixed basidia (1-2-3-4-spored basidia in the same specimen in *L. amethystina* are not rare), and although it is also true that the species with large spores are two-spored and those with small spores four-spored, there appears to be no real parallelism, and unless experimental studies show this hypothesis to be incorrect, I shall continue to assume that the bisporous forms of the Laccarias have become phylogenetically stable and correlated with additional small morphological characters that are constant; in other words that they have lost their original reversibility, and consequently their specific identity with the normal four-spored forms. With this reservation made the following fungus is described as a new species.

Laccaria tetraspora Sing. spec. nov.

Pileo hygrophano, pallide purpurascente-rosello in statu sicco, brunneolo-incarnato vel incarnato-roseo in statu humido, striato in statu humido, sulcato in statu sicco immo exsiccato, glabro vel fibrilloso, pellucido, convexo, dein applanato centroque depresso, in statu exsiccato umbilicato, saepe in statu vegeto etiam umbilicato, 10–20 mm. lato; cuticula paulum distincta, ex hyphis jacentibus elongatis efformata. Lamellis incarnato-roseis, latis, distantibus, adnato-decurrentibus, sporis pulveraceis; sporis hyalinis, fortiter echinatis, globosis, haud amyloideis, 7.5–14 × 7–13.5 μ, plerumque circa 11 × 10 μ, spinis pyramidalibus, 1.5–2.5 μ longis; basidiis tetrasporis, 40–50 × 11.5 μ; cystidiis nullis; cheilocystidiis praesentibus sed haud conspicuis; tramate admodum regulari, ex hyphis parallelis vel subparallelis elongatis, fibulatis consistente. Stipite subconcolori, subglabro, sicco, tomento myceliali albo haud fortiter evoluto, solido, aequali, vel base incrassato, 10–30 × 1.5–2.5 mm. Carne subconcolori-pallidiore, subfragili, inodora, insipida. Ad marginem viarum prope paludes vel prope silvas densas, nec non in silvis praecipue frondosis ad terram calcio depauperatam, gregatim, Junio usque ad Octobrem mensem. In America ad litus Atlanticum dispersa. Massachusetts, Prospect Hill near Waltham *W. G. Farlow* (FH); New York, Adirondack Mts. *W. A. Murrill*."examined for North American Flora" ut *L. striatula* Peck

(NY); Van Cortland Park prope N. Y. City, *R. Singer* (NY); Florida, Highlands Hammock State Park, R. Singer, *F 160* (FH), **typus**; Uruguay, Dep. Montevideo, *Herter, 1570* (Plantae Uruguayenses Exsiccatae), (FH), a much larger, otherwise identical form.

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MINERAL OIL AS A FUNGUS CULTURE PRESERVATIVE

C. C. WERNHAM

Sherf [1] in 1943 reported on the successful use of mineral oil as a preservative of bacterial cultures. *Fusarium* and *Alternaria* spp. subjected to the same test survived the treatment at least six months (extent of test), without any apparent change in morphology. The bacterial cultures maintained their pathogenicity as well as their viability.

Corynebacterium sepedonicum (*Phytomonas sepedonica*), the causal organism of bacterial ring rot of the potato, is exceedingly difficult to maintain in culture. Sherf was encouraged to try mineral oil as a preservative by several reports in the bacteriological literature that liquid paraffin prolonged the life of bacterial cultures on artificial media. The fungous cultures mentioned above were carried along in the experiment.

The method essentially is as follows: make fresh transfers of the bacterial or fungous culture. After these have grown to produce the growth normally expected of a transfer (10 days) the cultures are covered with a layer of sterile mineral oil sufficient to extend well above the slant. The tubes are replugged with cotton and held at room temperature. Transfers are made by passing a loop through the oil, scooping up a loopful of the colony, withdrawing the loop and momentarily holding it against the side of the tube to drain off the excess oil, and streaking the oil-drained loopful to a new slant. It is assumed that a needle was used for the fungous cultures.

At the time Sherf's article appeared, the writer was faced with the problem of maintaining a number of fungous cultures in a common laboratory refrigerator which periodically became infested with mites. The mineral oil technique looked like a possible solution to a troublesome and irritating problem.

[1] Sherf, Arden F. A method for maintaining *Phytomonas sepedonica* in culture for long periods without transfer. Phytopath. **33**: 330–332. 1943.

Four corn pathogens were selected for the experiment: *Diplodia zeae*, *Gibberella zeae*, *Cochliobolus heterostrophus* (*Helminthosporium maydis*) and *Nigrospora oryzae*. *Gibberella* and *Nigrospora* were completely submerged, the oil extending a full inch above the tip of the slant. *Diplodia* and *Helminthosporium* were covered to the extent of the lower portion of the slant. The slants of these latter two soon dried away from the test tube leaving the too familiar agar chip hanging to the edge of the tube. The fungous growth remained glistening with oil and proved easy of transfer. The former two cultures retained the normal slant of the freshly prepared culture. All cultures were retained at room temperature.

Transfers were made to fresh corn meal agar slants every three months. On March 15, 1946, these cultures had survived the treatment exactly two years.

At the end of 15 months the *Diplodia* and *Gibberella* cultures were used to prepare inoculum for field inoculations. There was no evidence of loss in pathogenicity. At the end of 23 months *H. maydis* was used to inoculate seedling corn plants in the greenhouse. Abundant infection resulted and the fungus was reisolated from the seedling leaves. Pathogenicity tests of the other fungi will be conducted during the summer.

These results have been so encouraging that the writer now keeps all his stock cultures under mineral oil. It is hoped that this note may encourage a wider use of Sherf's technique. I shall be glad to furnish subcultures of these fungi to anyone interested in checking the results herein reported.

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THE CHROMOSOMES OF NEUROSPORA TETRASPERMA [1]

VICTOR M. CUTTER, JR.

(WITH 1 FIGURE)

A comparison of McClintock's recent report (**1945**) on the structure and number of chromosomes in *Neurospora crassa* Shear & Dodge with earlier studies on this and related species brings out the possibility that significant variation exists in the morphology of the chromosomes of this genus. The present widespread interest in the physiological genetics of *Neurospora* emphasizes the need of an intensive cytological confirmation of pertinent genetic data in this genus. McClintock's study contrasted with other cytological investigations on the Ascomycetes may also lead to the conclusion that *N. crassa* is unique among fungi in possessing meiotic chromosomes large enough for easy study. However, her results were obtained with smear techniques not available to earlier workers in this field, and it is possible that these divergent reports are due to the use of different methods of preparation rather than to inherent differences in the species themselves. The purpose of this study is to investigate another species of *Neurospora* by similar smear techniques in order to determine whether the reported differences in the chromosomes are real or artifactual.

McClintock has reported a number of strains of *N. crassa* with seven haploid chromosomes. Beadle (**1946**), on McClintock's authority, also cites the haploid number as seven in this species whereas Lindegren and Rumann (**1938**) had previously reported its haploid number as six to nine. In the closely related eight spored species, *N. sitophila* Shear & Dodge, Wilcox (**1928**) figures six haploid chromosomes. Dodge (**1927**) does not state the chromosome number in the homothallic four spored species *N. tetrasperma* Shear & Dodge, but his figures lead to the conclusion that

[1] This work was partially summarized before the Microbiological Section of the Botanical Society of America at St. Louis, Mo., March 1946.

five or six haploid chromosomes were present in the strain he studied. Colson (**1934**) found six chromosomes in *N. tetrasperma*, while McClintock (**1945**) on the basis of unpublished observations reports seven haploid chromosomes in a strain of this species. A comparison of the figures published by these authors also suggests that differences occur in the morphology of the chromosomes of the various species and strains. This variability is of some theoretical interest since it implies that chromosome number and structure may be used as a clue to speciation in this genus.

N. tetrasperma was chosen to initiate this study because there were available for comparison the previous investigations of Dodge and Colson. This species is favorable for cytologic work since it is homothallic and readily forms abundant large perithecia with well developed asci. No attempt will be made to review the details of nuclear behavior throughout the life cycle since these have been adequately described by Dodge and Colson, and no further information of this type was obtained. Attention will be confined to the structure of the chromosomes as revealed in smears. All preparations were smeared and stained with aceto-carmine or aceto-orcein by the methods of McClintock (**1945**) and Cutter (**1946**). The fungus was cultured upon corn meal decoction agar or potato-dextrose agar made up according to the usual formulas. Perithecia containing asci in all stages of development were fixed and smeared seven to fourteen days after inoculation of the cultures. The culture used was obtained from the culture collection of the Department of Plant Pathology of the University of Minnesota through the kindness of Mr. C. W. Roane.

The somatic nuclei in the hyphae and conidia of this species are small and unexpanded (FIG. 1 *U*). Since aceto-carmine does not stain the spindle substance the chromatic masses stand out clearly during mitosis and this stain is very favorable for a study of such nuclei. The cytologic fixatives and stains commonly used in fungus work cause shrinkage of the chromatin and a clumping of the chromosomes in these unexpanded nuclei with resulting artifacts which have been frequently reported as amitoses. The chromosomes in somatic divisions are rarely more than a micron in length but they may be counted in properly oriented metaphase figures. The six chromosomes are quite uniform in length and configuration,

FIG. 1. Chromosomes of *Neurospora tetrasperma*.

but little can be determined about their structure. On the other hand the somatic nuclei of the sterile paraphyses and the basal cells of the hymenium are expanded and in these cells metaphase figures showing six chromosomes are easily interpreted (FIG. 1 *V*).

After syngamy in the young ascus of *N. tetrasperma* three nuclear divisions occur which result in the formation of eight nuclei. Ascospore walls are then delimited and two nuclei are incorporated in each of four spores (FIG. 1 *R*). Occasionally spore walls are

formed at the conclusion of the second division in which case the third and fourth mitoses are carried out within the spore membrane (FIG. 1 *Q*). Normally only the fourth mitosis takes place after ascospore wall formation. At maturity the ascospores are quadrinucleate and bisexual or homothallic.

Twelve very slender and somewhat contracted leptotene strands may be distinguished as the presynaptic fusion nucleus begins to expand following syngamy (FIG. 1 *C, D*). At this time prominent masses of chondriosomes are apparent in the tips of the asci and these presumably function in the accumulation of the oily materials in these regions. The leptotene strands pair rapidly and are so closely appressed during the early synaptic period that the doubled condition of the chromosomes is difficult to detect. At this time also the chromomeres enlarge and the synapsed chromosomes appear prominently beaded (FIG. 1 *E, F, G*). A bouquet arrangement of the chromosomes with the spindle attachment regions grouped close to the nuclear membrane (FIG. 1 *H*), is rather common during the zygotene and early pachytene stages. Two of the six pachytene chromosomes are noticeably longer than their mates. During their extreme elongation these two chromosomes may reach a calculated length of eight to ten micra. This is shorter than the lengths reported by McClintock for the corresponding first and second chromosome in *N. crassa*. One of these long chromosomes serves as the nucleolus organizer and is provided with a minute satellite (FIG. 1 *K*). The remaining four chromosomes are quite uniform in length and configuration and in pachytene they reach a length of four to five micra. At diakinesis there are six bivalents and a prominent nucleolus within the nuclear membrane (FIG. 1 *J, K*). During metaphase or early anaphase the nucleolus drifts out of the nuclear vacuole and is lost in the cytoplasm.

Centromere position has not been calculated in this fungus. The nucleolus is large and frequently obscures portions of the chromosomes particularly during the first division in the ascus. No heteromorphic chromosome pairs were seen. The prophase chromosomes become shorter in each successive division in the ascus, but they maintain their relative configuration. During the third division very prominent nuclear beaks or "spindle horns" are developed (FIG. 1 *P*). The structure and function of these is well

described by Colson. At the completion of the fourth mitosis in the ascospores the nuclei contract rapidly and sink into the unexpanded state. At this time the central body or nucleolus appears eccentric within the membrane (FIG. 1 *S*). Shortly thereafter this central body is either cast out of the nucleus or loses its chromaticity, for in the unexpanded condition the nuclei are quite homogeneous in appearance (FIG. 1 *T*).

The results of this preliminary study confirm Colson's report of six haploid chromosomes in *N. tetrasperma*, and also emphasize the fact that chromosome morphology may provide a basis for studies on speciation in this genus and related ascomycetes. The chromosomes are sufficiently large for easy study, and they may offer very favorable material for a study of the chromosomal basis of homothallism.

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EXPLANATION OF FIGURES

All figures drawn with the aid of a camera lucida at an approximate magnification of × 1300.

FIG. 1, *A–B*. Syngamy in young ascus hooks. *C–D*. Developing asci showing leptotene chromosomes. *E–I*. Stages in synapsis. Note bouquet arrangement of chromosomes in *H*. *J–K*. Diakinesis stages showing six

bivalents and nucleolus. In *K* the ascus has been crushed and the nuclear membrane ruptured. *L*. Metaphase I. *M*. Anaphase I. *N*. Prophase II late stage. *O*. Prophase III. *P*. Metaphase III, note nuclear beaks. *Q*. Third division stages in abnormal ascus where ascospore wall formation followed the second nuclear division. *R*. Fourth division stages in normal ascus where ascospore wall formation followed third nuclear division. *S–T*. Quadrinucleate ascospores in maturing asci. Note nuclei entering unexpanded state. *U*. Multinucleate macroconidia with unexpanded nuclei. *V*. Somatic mitoses in paraphysis.

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New Members

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DECEASED

ERNST BERNHARDT
ROBERT HAGELSTEIN
D. H. LINDER
L. O. OVERHOLTS

RESIGNED

C. L. BEDFORD
A. F. BLAKESLEE
H. S. CONARD
R. B. HARRIS
F. D. HEALD
H. C. JOHNSON
E. M. MARTIN
BERNICE SEAVER

News has just been received that both Dr. L. O. Overholts of Pennsylvania State College and Dr. D. H. Linder, of Harvard University died on Sunday, November 10, 1946. Both men had given freely of their time and energy to advance mycology, and both had served as president of our Society. Detailed biographical accounts will appear in MYCOLOGIA in due time. A. H. Smith.

MYCOLOGICAL SOCIETY OF AMERICA

FINANCIAL STATEMENT, 1945

Balance on hand, December 21, 1944:		
Cash	$ 957.23	
Bonds	940.00	
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Total	$2138.54	$2138.54
Receipts:		
Annual dues, part 1945, part 1946	$1720.00	
Interest on savings account Purdue bank	3.62	
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Examined and found correct:

E. B. MAINS, *Chairman of Auditing Committee*

April 25, 1946.

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